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APPLICATION OF POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 46
Main Document

December 2001

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

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Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)
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The Wastewater Group of the EPIQ Water Policy Team authored this document. The group included Eng. Nasser Ezzat (Co-Task Manager), Dr. Zhongping Zhu (Co-Task Manager), Mr. Jeffrey H. Hendrich, Dr. Ibrahim Elassiouti, and Dr. Ahmed Fakhry Khattab.

Special thanks are given to the pilot project team members and authors of the following five Appendices to this document, for if not for the time and effort extended by these individuals, this final benchmark report would not be possible.

Appendix A	Phase I Policy Reforms
Appendix B	Drain Classification and Wastewater Treatment Plant Construction Prioritization in El Salaam Canal By Eng. Mohamed Fathy Hassan, Engr. Abdel Moniem Hamza and Eng. Mohamed Khazragy of EDADP
Appendix C	Wastewater Irrigation for Urban Green Lands By Dr. Mamdouh Riad of MALR
Appendix D	Health Awareness and Wastewater Quality Monitoring of El Salaam Canal By Dr. Sehem Hendi of MOHP
Appendix E	An Industrial Wastewater Management Action Plan for El Salaam Canal By Dr. Samia Gala Saad of EEAA

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The EPIQ Water Policy Reform Program (WPRP) is a joint activity of the Ministry of Water Resources and Irrigation (MWRI) and the US Agency for International Development (USAID). It is carried out under the auspices of the Agricultural Policy Reform Program (APRP). Program implementation is the responsibility of Winrock International, International Resources Group, and Nile Consultants.

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Acronyms and Abbreviations

APRP	Agricultural Policy Reform Program
BCM	Billion Cubic Meters
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EEAA	Egyptian Environmental Affairs Agency
GOE	Government of Egypt
M&I	Municipal and industrial
MALR	Ministry of Agriculture and Land Reclamation
MCM	Million Cubic Meters
MOHP	Ministry of Health and Population
MHUUC	Ministry of Housing, Utility, and Urban Communities
MWRI	Ministry of Water Resources and Irrigation
NOPWASD	National Organization for Potable Water and Sanitary Drainage
O&M	Operations and Maintenance
USAID	United States Agency for International Development
TDS	Total Dissolved Solid
WHO	World Health Organization
WPAU	Water Policy Advisory Unit
WWTP	Wastewater Treatment Plant

Executive Summary

Introduction

The purpose of this document and its separately bound appendices is to present the results of the work carried out under Tranche IV, Benchmark C2, Phase II of the Memorandum of Understanding between the Arab Republic of Egypt (GOE) and USAID/Egypt for the Agricultural Policy Reform Program (APRP). The draft version of this report and its appendices were presented and discussed at the Tranche IV final workshop and subsequently adopted by the Steering Committee.

Specifically, this benchmark states that:

> *The GOE (MWRI) will adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains*

The verification indicators that the benchmark has been successfully achieved require that:

> *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000, and;*
>
> *The MWRI in coordination with other ministries and authorities will apply the policy and procedures in one selected pilot area in the Delta by December 2001.*

Background

As elsewhere, water pollution in Egypt results from domestic, municipal, commercial, industrial, and agricultural activities. Among the many contaminants associated with water pollution, pathogens and viruses, heavy metals, persistent and degenerative chemicals, macronutrients, and salinity are the primary issues of concern.

Presently, a large volume of concentrated municipal and industrial (M&I) wastewater is discharged in agricultural drains. This unmanaged waste load degrades water quality to varying degrees throughout the national drain and irrigation system. Pollution of drains is of particular concern since drain water is reused for agriculture and the existing potential for human contact with polluted drain water is high.

Water quality protection is an essential component of Egypt's water management, particularly in light of Egypt's growing water pollution problem and practice of reusing drainage, and level of human exposure. Until recently, the effects of surface water pollution have not been integrated into the national water resources management strategy. Better management of M&I wastes in drains is necessary to protect the health and well being of Egyptians and the Egyptian environment. Unmanaged M&I waste discharges to drains should therefore receive priority consideration in Egypt's water pollution control efforts.

There are three major concerns with regard to wastewater discharging to agricultural drains:

1. Unmanaged discharge of wastewater to drains also impacts the water quality of the canals and lakes of Egypt and ultimately the Mediterranean Sea;
2. Pollution of the country's irrigation network poses increased risks to the environment and to the Egyptian people, and;
3. Contamination of drain water threatens the sustainability of drainage reuse.

Fundamentally speaking, four principle elements of the existing drain-water management strategy need to be addressed with regard to wastewater discharged to drains. These include**:**

- Developing and applying appropriate water quality management tools and systems;
- Creating a non-biased means to prioritize and expedite the construction of wastewater treatment infrastructure to maximize the benefit realized by limited resources, better protect human and environmental health, and support the MWRI drainage reuse policy.
- Promoting health and environmental awareness among the wastewater management community, farmers, and the public at large, and;
- Investigating and applying ways to best utilize and exhaust treated wastewater directly from its point of discharge as a productive asset.

The APRP Urban Wastewater Discharge and Reuse (UDWR) Benchmark was undertaken to develop these elements. The objectives of activities carried out under this benchmark were to:

- Establish integrated policies for handling urban waste disposal and reuse;
- Enhance compliance with the objectives of current applicable Egyptian environmental law; and;
- Promote coordination and implementation between MWRI and other ministries in water pollution control and environmental quality management.

To achieve these goals, the benchmark was structured as a two-phase program spanning a period of two years. During Phase I, a policy for improving urban wastewater discharge and reuse was developed and approved. Phase II consisted of applying the approved policy reforms in the form of a pilot program.

Phase I of this benchmark was completed in December of 2000. During Phase I a policy consisting of 11 reforms was drafted and approved by MWRI. The eleven reforms included in the policy address:

Reform Policy #1 – Prioritization of Wastewater Treatment Plants
Reform Policy #2 – Improving Performance of Existing Wastewater Treatment Plants
Reform Policy #3 – Classification of Drains with Consideration for Water Quality
Reform Policy #4 – Wastewater Irrigation and Public Health Awareness
Reform Policy #5 – Wastewater Quality and Regulatory Development
Reform Policy #6 – Separation, Classification, and Intermediate Reuse of Drains
Reform Policy #7 – Drainage Water quality Monitoring
Reform Policy #8 – Restricted Irrigation for Crop Use
Reform Policy #9 – Wastewater Irrigation for Desert Forests
Reform Policy #10 -Wastewater Irrigation of Urban Green Lands
Reform Policy #11- Inter-ministerial Co-operation

EPIQ report No. 34 presents a detailed account of Phase I activities and accomplishments. After approval from the MWRI, the APRP Monitoring and Evaluation Unit; USAID reviewed the approved policy. The review resulted in mutual agreement of all of the parties that the Phase I indicator had been fully accomplished.

Phase II consisted of applying the policy approved under Phase I. The intent was to apply the policy as a pilot demonstration designed and implemented within the constraints associated with a one-year program.

Pilot Program and Pilot Area

El Salaam Canal in the eastern Nile Delta was chosen as the study area for the pilot projects. This drainage was selected since it is the most significant ongoing irrigation expansion project currently underway in the Delta region. Completion of El Salaam will mark the first time in the history of the Republic of Egypt that Delta irrigation water will flow into the Sinai. Water quality is of great concern in El Salaam Canal because the North Sinai is relatively free of the pollution and the waterborne diseases associated with poor drain water quality that exists elsewhere in Egypt. It is critical; therefore, that water pollution and its associated negative potential impacts are minimized in mixed irrigation water before it reaches the Sinai.

Time constraints were a significant factor in selection of the pilot demonstrations to be included under Phase II. The working group concluded that it was not feasible to apply all eleven reforms during the one-year demonstration. Review of ongoing GOE efforts revealed that six of the eleven policy reforms were already being initiated under other ministry activities. Therefore, it was decided to apply only the remaining five reforms as shown in Table E-1.

Table E-1 Tranche IV, Phase II C2 Pilot Projects

Pilot Project	Policy Reform	Recommended Activity	Contributing Agencies
1	6	Organize and develop an overall drain classification program	MWRI, EDADP, NOPWASD, and Dakhalaiya, Sharkia, Damietta Municipal Authorities,
2	1	Prepare a prioritized construction and implementation plan for wastewater treatment plants	NOPWASD, EDADP, MWRI
3	10	Conduct a pilot program using treated wastewater effluent to irrigate an urban green land	MALR, MWRI, and Dakhalaiya Governorate,
4	4	Conduct public awareness workshops to disseminate knowledge of proper wastewater irrigation management practices and expand water quality monitoring activities	MOHP, MWRI, NOPWASD
5	3	Develop a plan of action for the management of industrial wastes to drains	MWRI, EEAA

Pilot Project #1: Classification of Drains:

Pilot Project #1, Classification of drains, applied Policy Reform #6. Under this pilot project, EDADP worked closely with MWRI, and local Governorates of Dakhalaiya, Sharkia, and Damietta to develop and implement a drain classification methodology in the West Salaam Pilot Area.

Classifying drains in terms of water quality brings to light several important implications with regard to drain classification and its future role in water reuse management in Egypt. In practice it was found that drain classification has application as:

- An analytical tool, to assess the extent and magnitude of the drain-water pollution problem;
- A management tool, to optimize drain-water harvesting, mixing, and allocation strategies, and;
- A planning tool, to identify the location and extent of pollution mitigation measures, predict the effect that these measures will have on general water quality and assessing this effect in terms of water reuse efforts.

The pilot demonstration confirmed the benefits of classifying drains and concluded that a national classification database should be developed and maintained. This database should be periodically reviewed and updated to reflect changes in drain conditions. This data should be made available to all concerned GOE ministries.

Pilot Project #2: Prioritization of Wastewater Treatment Plant Construction:

In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The objectives for prioritizing the construction of wastewater treatment plants should be:

- To protect human health;
- To sustain agricultural drainage reuse, and;
- To maintain ecological balance in lakes and seashores.

EDADP, in collaboration with NOPWASD and MWRI, developed a screening methodology to prioritize wastewater treatment plant construction activities. EDADP applied this methodology to prepare a prioritized construction and implementation plan for wastewater treatment plant construction activities in the pilot area for the period 2000-2007. This list considered the aforementioned water quality objectives, available budget, and current on-going NOPWASD construction activities within the Pilot Area.

The findings of Pilot Project #2 revealed that prioritization of WWTP Construction Activities to achieve specific drain water quality targets provide two major benefits. Prioritization:

1. Focuses NOPWASD's limited resources on the most critically needed improvements hastening project completion times, and;

2. Maximizes the positive impacts gained through better water quality supporting MWRI drain-water reuse efforts.

It is recommended that the principal of prioritizing wastewater treatment facility construction activities with consideration for drain water quality be integrated into NOPWASD's project selection criteria. Prioritization of NOPWASD construction activities should be expanded to the rest of the Nile Delta Region and the country. NOPWASD should continue to work closely with the MWRI, MOHP, and EEAA to ensure that the charters of all ministries are best met through the continued effort to expand sanitary coverage in Egypt.

Pilot Project #3: Wastewater Irrigation of Urban Green Areas

Development and implementation of beneficial uses for wastewater can reduce water pollution and augment Egypt's fixed freshwater supply. Irrigation of urban green lands with treated wastewater is one such beneficial use for wastewater proposed under this benchmark as Policy Reform #10 by the task group. To apply Policy Reform #10, The Afforestation Department of MALR, in cooperation with MWRI and Dakhalaiya Governorate, conducted a pilot program using wastewater effluents to grow ornamental trees along a section of highway 9N in Dakhalaiya Governorate.

Pilot Project #3 successfully demonstrated that the use of wastewater for irrigation of urban green lands is a feasible use for treated wastewater. Municipal wastewater is proving to be an excellent source of both water and nutrients for timber plantations in the desert. The application of treated wastewater for these forests is restricted to unpopulated desert areas and thus can be conducted without restriction. The use of wastewater to irrigate urban green lands will be conducted in established and growing urban areas and thus carries with it additional siting considerations such as:

- Public exposure issues
- Environmental impacts;
- Limiting site conditions, and;
- Cost / benefit considerations.

In light of the successes of Pilot Project #3, the final review of the task group concluded that the practice of wastewater irrigation of urban green lands is a feasible but limited application of wastewater reuse. This practice should be expanded to other areas after applying site selection criteria and confirming cost effectiveness on a project by project basis.

Pilot Project #4: Health Awareness and Water Quality Monitoring

The Environmental Health Department of MOHP, in cooperation with the MWRI and the Dakhalaiya Governorate Authority, applied Policy Reform # 4 by continuing and expanding MOHP's roles in promoting public awareness on health issues related to wastewater treatment / reuse and wastewater quality monitoring.

MOHP promoted health awareness by leading two workshops focused on health concerns related to the exposure to wastewater and contaminated drainage. The workshops presented proper management practices and safety precautions to consider when working with wastewater treatment and reuse. Workshops targeted wastewater treatment personnel, farmers, health workers, and crop handlers.

Participant feedback from the two workshops indicated that understanding of the risks and mitigation measures available for those who work with, or utilize treated wastewater is limited. Moreover, the participants indicated that the workshop content was beneficial for them. The workshop results confirmed that public awareness and education are important components of proper management practices and protection measures necessary to minimize inherent risks associated with wastewater treatment and reuse. It is therefore recommended that public awareness and education efforts propagating the best management practice for wastewater reuse and protective measures for health protection from wastewater-related disease be continued and expanded. MOHP should take the lead role in this endeavor but should involve the MWRI and EEAA in developing and administering a national public awareness campaign addressing water reuse and health-related issues.

The MOHP applied Ministerial Decree No. 44/2000 by continuing and expanding its water quality monitoring in El Salaam Canal Catchment Area to include sampling points critical to drainage reuse in El Salaam Catchment. The MOHP conducted one complete round of sampling and analysis of water samples from these selected points.

Analysis of water quality testing results reveal that while water quality standards are within acceptable limits for irrigation by the time water reaches the Sinai, parameters critical to health related concerns such as coliform and helminth counts exceed legal limits upstream in El Salaam Canal. Increased sanitary coverage and better waste management must be realized in order to reduce potential human risks associated with drains feeding El Salaam Canal. Continued water quality monitoring of wastewater discharges and drain-water quality in El Salaam Canal is necessary to:

- Insure compliance with pertinent Egyptian environmental law;
- Enforce penalties for non-compliance;
- Implement proper drain-water reuse management planning, and;
- To insure that water of adequate water quality is delivered to the North Sinai Reclamation Project.

It is therefore recommended that the MOHP should:

- Bolster its efforts in wastewater treatment plant monitoring in-step with the expansion of wastewater treatment plant commissioning activities;
- Expand its monitoring responsibilities to include drains critical to drainage reuse, and;
- Continue to work closely with MWRI, NOPWASD, and EEAA to ensure enforcement and compliance with pertinent Egyptian environmental laws, and to provide the necessary water quality data for informed drainage reuse management planning.

Pilot Project #5: Management of Industrial Wastes in Drains

Pilot project #5, Management of Industrial Wastes in Drains, entailed conducting a survey of industries discharging to The West Salaam Canal Drainage and developing a plan of action to improve management of industrial wastes discharged to drains within the study area.

Management of industrial waste discharges to drains by large, small, and micro-scale industries is a critical issue not only in considering the potential direct human and environmental consequences associated with this practice, but especially in light of Egypt's present need to reuse drain water.

In recognition of the findings of the Industrial Waste Survey conducted in West El Salaam Canal, an action plan to address industrial waste dumping to drains was conceived. Representatives of the MWRI and EEAA drafted this action plan and presented it to local government representatives, community leaders, and industry representatives in a final workshop in Mansoura City in September 2001. The action plan was amended to include the ideas and recommendations of the Governorate of Dakhalaiya and local industry leaders. The final action plan addresses the current issues confronting industrial waste management and the discharge of these wastes to drains. The recommended action plan consists of five principal components, those being:

- Strengthening of monitoring and enforcement of wastewater quality standards from large industries;
- Surveying wastewater discharges from medium, small, and micro-scale industries;
- Promoting and supporting a public awareness campaign emphasizing the importance of industrial waste management;
- Mandating compliance with existing environmental laws, and;
- Promoting and environmental services industry.

The proposed plan of action should be implemented in the West Salaam Pilot Area. It should then be refined and expanded to include other drainages. Priority should be given to drains that are currently impacting drainage reuse efforts.

The results, findings and recommendations of this benchmark were presented to the MWRI Water Policy Steering Committee at the final Tranche IV Benchmark Workshop held on Nov. 9-10, 2001. The draft version of this report and its appendices were made available to the Steering Committee members and other key officials of MWRI, USAID and other involved GOE entities. Following comprehensive discussion and deliberation, the draft report was adopted by the Steering Committee. The Steering Committee subsequently forwarded its recommendations for this benchmark to H.E., the Minister of MWRI, for approval.

1 Introduction

1.1 Overview

The Agricultural Policy Reform Program (APRP) is a five-year United States Agency for International Development (USAID) grant program involving several ministries. The Ministry of Water Resources and Irrigation (MWRI) is the lead Egyptian governmental agency charged with the management of water resources. The MWRI and USAID, under the umbrella of the APRP, jointly designed a water policy package consisting of integrated water policy and institutional reforms. USAID supports the Ministry's policy reform efforts by providing technical assistance and annual cash transfers based on performance in achieving identified and agreed upon policy reform benchmarks.

Coordination among MWRI, USAID, and the water policy technical assistance program is through the Water Policy Advisory Unit (WPAU) and a project steering committee established by the MWRI. Technical assistance for the water policy analysis activity is provided through a water resources results package task order (Contract PCE-I-00-96-00002-00, Task Order 807) under the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ) between USAID and a consortium headed by the International Resources Group (IRG) and Winrock International. Local technical assistance and administrative support is provided through a subcontract with Nile Consultants.

1.2 Purpose of the Report

A Memorandum of Understanding between the Arab Republic of Egypt and USAID, dated 20 September 1999, listed the mutually agreed policy reform benchmarks for APRP Tranche IV period (1 July 1999 - 2000-31 December 2001). The purpose of this report is to document the activities of MWRI under Tranche IV, C2 Benchmark (Urban Wastewater Discharge and Reuse), which states:

> *The GOE (MWRI) will adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains.*

Implementation of this Urban Drainage and Wastewater Reuse Program (UDWR) benchmark extended through two years. Satisfactory achievement of the benchmark requires the accomplishment of the following two verification indicators.

- *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000.*

- *The MWRI, in coordination with other ministries and authorities, will apply the policy and procedures in one selected pilot area in the Delta in December 2001.*

The overall timeline for work on this benchmark is 1 July 1999 through 31 December 2001. The Benchmark was divided into two phases:

Phase I - 1 July 1999 – 31 December 2000, and;
Phase II - 1 January 2001 – 31 December 2001.

Phase I consisted of drafting and obtaining approval of a policy related to wastewater management. This phase was successfully completed during 1999. The goal of Phase II was to apply the policy in a pilot area in the Nile Delta region.

1.3 Background

The Arab Republic of Egypt is a dynamic, rapidly growing, and developing nation. Today (2001), the Nile Valley River supports a population of 68 million Egyptians (GOE Census 1999), and an arable land area of approximately 8 million feddans. The Egyptian population is roughly half urban and half rural. Approximately 45 million people inhabit the Nile Delta region alone, extending from Cairo to the Mediterranean Sea. The majority of the urban population in this region inhabits Egypt's two principal metropolitan areas, Cairo and Alexandria. The remainders live in governorate centers and in scattered smaller cities. The rural population is primarily agrarian. Generally, however, rural agrarians do not live on the land that they farm but tend to inhabit nearby towns, villages, and *esbas* (hamlets) throughout the Nile Valley and Delta region.

Rapid growth of Egypt's population and substantial industrial development has significantly increased the country's demand for water, and consequently, its production of wastewater. Currently, the population of the Delta region generates roughly 2.3 billion cubic meters of wastewater annually; (20%) of the total national wastewater load. 1.2 BCM/year is produced by Cairo alone. Limited investment of wastewater collection and treatment infrastructure in the past has resulted in a significant shortfall in sanitary coverage and a growing surface water pollution problem. The discharge of raw and insufficiently treated wastes to the Nile, its canals, and drains, has contaminated many regions of the country's irrigation and drainage system. Water pollution in the Delta Region tends to be greater than in other regions of Egypt since it is at the tail end of the Nile River system and maintains the highest population density in the country. Pollution of the Delta came to a head in 1996 when six major reuse pump-stations in the region were closed due to poor drain water quality. This, in combination with substantial fisheries losses in Egypt's northern and inland lakes, make apparent the need for serious policy reform actions to combat additional pollution and further degradation of Egypt's freshwater resources. Several environmental laws such as Laws 48, 44, and 4 have been instated to begin to address this growing water pollution problem.

As elsewhere, water pollution in Egypt results from domestic, municipal, commercial, industrial, and agricultural activities. Among the many contaminants associated with water pollution, pathogens and viruses, heavy metals, persistent and degenerative chemicals, macronutrients, and salinity are the predominate issues of concern regarding Egypt's water environment.

Agricultural drains are of particular concern with regard to pollution since drains:

- Are the recipients of all types of liquid and solid wastes;
- Receive a large degree of human exposure, and because;

- Drain water is reused as part of the irrigation source in Egypt, a practice that will continue in the future.

As a result of these and other existing conditions, better management of M&I wastes is necessary to protect the health and well being of Egyptians and the Egyptian environment. Addressing the large volume of concentrated M&I wastewater discharged to Egypt's agricultural drains is a critical component of any plan to manage water pollution in Egypt therefore this issue should receive priority consideration in the GOE's future water pollution control efforts.

There are two major issues related to untreated wastewater discharges in agricultural drains:

- Pollution in the Nile system, particularly in agricultural drains, poses increasing risks to human and environmental health due to the public's high level of exposure to drains; particularly where adequate fresh water is in short supply, or where poor sanitary disposal conditions (high water table) limit potable water use.
- Large volume and concentrated discharges of wastewater in agricultural drains increasingly threaten the sustainability of drainage reuse in the Delta by decreasing the amount of reusable drainage.

Water quality should be an essential component of Egypt's water management; however presently, the effects of the growing water pollution problem have not been adequately integrated into the current national water resources management strategy. The APRP Tranche III Benchmark C.8 (Law 48 Amendment) represents one initial effort to address water quality issues within a policy and legislative framework. Benchmark C8 recommends a compliance action plan for pollution abatement. An important component of this plan is the management of wastewater discharge in agricultural drains.

Four critical elements of the existing drain-water management strategy that need to be addressed with regard to improve water quality management in drains are:

- Developing and applying appropriate water quality management tools and systems;
- Developing a non-biased means to prioritize and expedite the construction of wastewater treatment infrastructure to maximize the benefit realized by limited resources, better protect human and environmental health, and support the MWRI drainage reuse policy.
- Promoting health and environmental awareness among the wastewater management community, farmers, and the public at large, and;
- Investigating ways to best utilize treated wastewater as a productive asset.

The APRP Tranche IV Benchmark C.2 establishes and applies integrated policies and procedures for managing urban wastewater discharge and reuse. The objectives of Benchmark C.2 are to:

- Develop an integrated policy for handling urban wastewater disposal and reuse;
- Enhance compliance with pertinent Egyptian environmental law, and;
- Promote coordination and implementation between MWRI and other ministries in water pollution control and environmental quality management.

Anticipated effects for this benchmark include:

- Integration of MWRI strategies for discharging and reusing urban wastewater with the strategies of other ministries;
- Enhancement of MWRI capabilities in managing urban wastewater; and
- Improvement of inter-ministry coordination in urban wastewater disposal and reuse.

1.4 Inter-ministerial Cooperation

Accomplishing benchmarks under APRP requires the active involvement of numerous ministries and agencies. In recognition of this fact, an APRP/MWRI Wastewater Task Group was organized with representatives from five ministries and agencies to coordinate and oversee the activities carried out under the UWDR benchmark. Ministries and agencies represented in the UDWR wastewater Task Group include the:

- Ministry of Water Resources and Irrigation (MWRI / EDADP)
- Ministry of Agriculture and Land Reclamation (MALR)
- Ministry of Health and Population (MOHP)
- National Organization of Potable Water and Sanitary Drainage (NOPWASD) of the Ministry of Housing, Utilities, and Urban Communities (MHUUC)
- Egyptian Environmental Affairs Agency (EEAA)

Participation, cooperation, and consistent policy development from all involved ministries were targeted from the very beginning of the benchmark program design as a principle objective of inter-ministerial cooperation is the contribution of each party's experience and wisdom for a commonly agreed-upon policy.

1.5 Benchmark Activities

APRP Tranche IV, Benchmark C.2 has a two-stage implementation plan: Phase I (July 1999 – December 2000) resulted in the development and approval of policy reforms and accompanying procedures related to national water resource management. Phase II (December 2000 – December 2001) was dedicated to applying the approved policies and procedures in one pilot area in The Nile Delta.

Under Phase I, the following major activities were conducted:

- Established a conceptual framework to guide the policy development;
- Organized an APRP/MWRI Wastewater Task Group to carry out benchmark activities;
- Conducted a sampling program for the water microbial features in El Salaam Canal, its feeding drains, and the effluents of the Mansoura wastewater treatment plant;
- Participated in MOHP-WHO sponsored wastewater irrigation training to promote public awareness;
- Conducted international study tours to Jordan and California, USA;
- Organized inter-ministry policy development;
- Drafted and facilitated GOE Cabinet approval of eleven policy reforms to better address water quality management of drains and drainage reuse.

Phase II was a continuation of Phase I activities based upon the recommendations of the APRP/MWRI Wastewater Task Group. Activities accomplished under Phase II included:

- Continuation and further development of inter-ministerial cooperation and collaboration;
- Selection, design and development of five pilot projects to implement approved policy reforms not already applied under other on-going ministerial activities;
- Selection of a pilot study area;
- Assigning pilot projects to respective ministry representatives;
- Providing management oversight of pilot project activities;
- Presentation of the pilot project findings, recommendations, and policy implications, and;
- Preparation and submission of a Final Benchmark Report detailing benchmark activities, results, and implications.

Phase I of this benchmark was completed in December of 2000. During Phase I a policy consisting of 11 reforms was drafted and approved by MWRI. The eleven reforms included in the policy address:

Reform Policy #1 – Prioritization of Wastewater Treatment Plants
Reform Policy #2 – Improving Performance of Existing Wastewater Treatment Plants
Reform Policy #3 – Classification of Drains with Consideration for Water Quality
Reform Policy #4 – Wastewater Irrigation and Public Health Awareness
Reform Policy #5 – Wastewater Quality and Regulatory Development
Reform Policy #6 – Separation, Classification, and Intermediate Reuse of Drains
Reform Policy #7 – Drainage Water quality Monitoring
Reform Policy #8 – Restricted Irrigation for Crop Use
Reform Policy #9 – Wastewater Irrigation for Desert Forests
Reform Policy #10 -Wastewater Irrigation of Urban Green Lands

As previously mentioned Phase II of the UWDR Benchmark required the application of Phase I policies. Time constraints were a significant factor in selection of the pilot demonstrations to be included under Phase II. Therefore, the UDWR Wastewater Task Group concluded that it was not feasible to apply all eleven reforms during the one-year demonstration. Review of ongoing GOE efforts revealed that six of the eleven policy reforms were already being initiated under other ministry activities therefore the remaining five policy reforms were selected for additional pilot testing. Table 1.1 provides a summary of Pilot Studies and the recommended actions of the Phase I Steering Committee.

Table 1.1 Summary of Recommended Pilot Studies

Pilot Project	Policy Reform	Recommended Activity	Contributing Agencies
1	6	Organize and develop an overall drain classification program	MWRI, EDADP, NOPWASD, and Local Municipal Authorities
2	1	Prepare a prioritized construction and implementation plan for WWTPs	NOPWASD, MWRI, EDADP
3	10	Conduct a pilot program using wastewater effluents to irrigate and urban green land	MALR, MWRI, and Dakhalaiya Governorate,
4	4	Conduct public awareness workshops on wastewater irrigation management practices. Expand water quality monitoring activities	MOHP, MWRI
5	3	Develop an Immediate Plan of Action for the management of industrial wastes to drains	MWRI, EEAA

1.6 Selection of Appropriate Pilot Study Area

Selection of the pilot study area where Phase I policy reforms would be applied was based upon three criteria. Based upon these criteria the selected pilot area must:

1. Have identifiable problems to be addressed by the applied policy reforms;
2. Stand to benefit from policy reform applications, and;
3. Be situated within reasonable proximately of participating ministry offices to minimize travel requirements of pilot project staff.

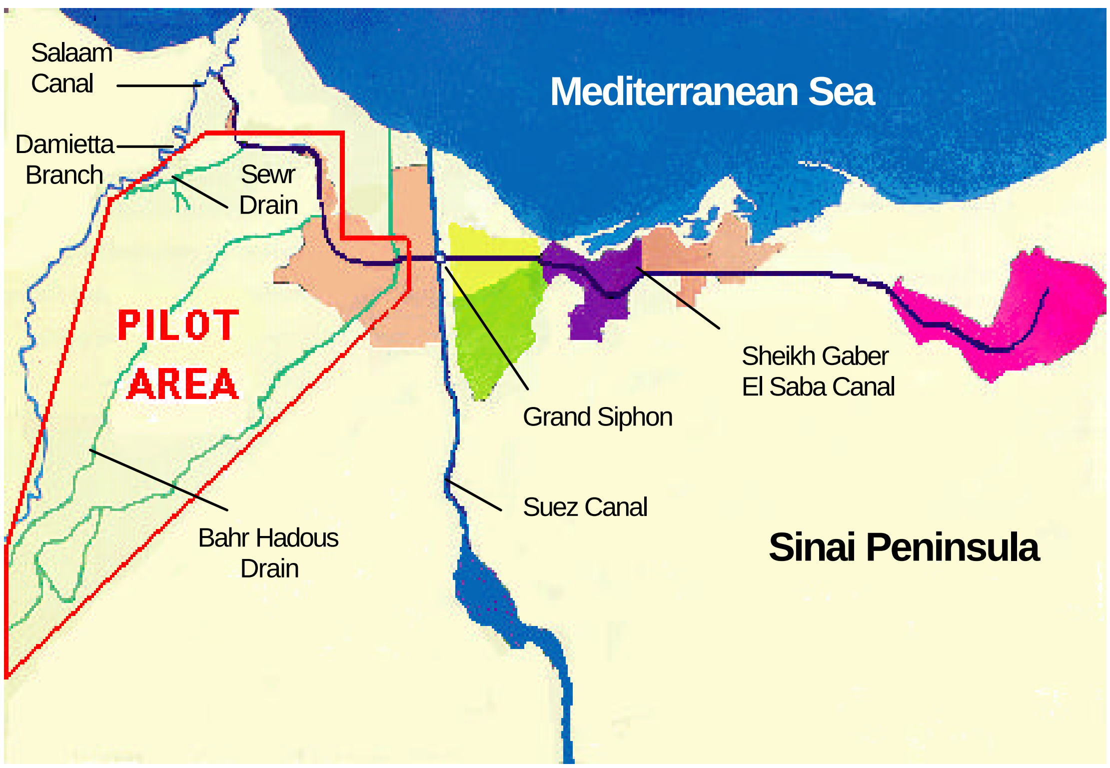
El Salaam Canal was selected as the study area for all of the pilot projects since this it is a key focus of the MWRI and is the most significant on-going irrigation expansion project currently underway in the Delta Region. El Salaam represents not only a large addition to the East Nile Delta irrigation reuse system and a significant investment on the part of the GOE, but more significantly, completion of El Salaam marks the first time in the history of the Republic of Egypt that Delta irrigation water has flowed in the Sinai.

Water quality is of great concern in El Salaam Canal because the North Sinai is relatively free of the pollution and waterborne diseases associated with poor drain water quality elsewhere in Egypt. There is concern that El Salaam Canal, if not properly managed, could become a major pollutant conveyance mechanism to the Sinai. It is critical therefore; that water pollution and its associated negative potential impacts are minimized in mixed irrigation water before it reaches El Salaam Canal and El Sheikh Gaber El Sabah Canal.

The project area selected is located within the governorates of Dakhalaiya, Sharkia, and Damietta and includes the Salaam Canal and its major drainage catchment area. The intake of El Salaam begins at Damietta Branch of the River Nile, 219 kilometers west of The Suez Canal. It first flows northeast toward Lake Manzalla but veers to the East, where it meets with Serw Drain. El Salaam Canal then flows southeast, where it joins the confluence of The Bahr Hadous Drain. Finally, water is conveyed under the Suez Canal through “the Grand Siphon,” located some 28 kilometers south of Port Said, to the North Sinai Peninsula. Water emerges from the siphon on the Sinai Peninsula as El Sheikh Gaber El Sabah Canal, bringing water to El Aareesh Valley. Figure 1.1 provides a map of the study area.

Under the proposed management scheme, El Salaam will transport fresh Nile water mixed with drain water from the east Nile Delta to the Sinai Peninsula. Fresh water will be diverted from the Damietta Branch of The Nile River. This fresh water will be mixed with drain water harvested from two major drain systems in the Eastern Nile Delta: the Lower Serw and Bahr Hadous Drains. Mixed water will be used to reclaim 200,000 feddans of desert land on the western side of the Suez Canal and an additional 440,000 feddans in the Northern Sinai.

Figure 1.1 Map of El Salaam Canal Irrigation Project



1.7 Organization of the Report

This final benchmark report details pilot project activities, findings, and policy implications for the purpose of supporting successful completion of the Tranche IV UWDR benchmark. Chapter 1 provides the background, identifies the participating parties and summarizes the major activities that have been conducted under this Benchmark. Chapter 2 presents a brief summary of the Phase I activities and accomplishments. Each of the five pilot projects is described individually in chapters 3 through 7.

Finally, this report is supported by five appendices consisting of the individual pilot project reports prepared by their responsible ministerial representatives and the policy that was approved under Phase I:

Appendix A	Approved UDWR benchmark policies and procedures
Appendix B	Drain Classification and Wastewater Treatment Plant Construction Prioritization (EDADP, NOPWASD);
Appendix C	Wastewater Irrigation of Urban Green Lands (MALR);
Appendix D	Health Awareness and Water Quality Monitoring (MOHP);
Appendix E	Management of Industrial Wastes in Irrigation Drains (EEAA)

Appendices are bound in a separate volume to this final benchmark report.

1.8 Steering Committee Approval

The results, findings and recommendations of this benchmark were presented to the MWRI Water Policy Steering Committee at the final Tranche IV Benchmark Workshop held on Nov. 9-10, 2001. The draft version of this report and its appendices were made available to the Steering Committee members and other key officials of MWRI, USAID and other involved GOE entities. Following comprehensive discussion and deliberation, the draft report was adopted by the Steering Committee. The Steering Committee subsequently forwarded its recommendations for this benchmark to H.E., the Minister of MWRI, for approval.

2 UDWR Benchmark Phase I Activities and Accomplishments

As previously mentioned, the UDWR benchmark was divided into two phases. Phase I (November 1999 – December 2000) of this benchmark required that:

> *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000.*

Under Phase I, the following major activities were conducted and achievements realized:

- Established a conceptual framework, including the identified critical areas of urban wastewater management, to guide the policy development;
- Organized an APRP/MWRI Wastewater Task Group to carry out benchmark activities. The group, composed of eight representatives from the five cooperative ministries and agencies, met every 2-3 weeks, and organized four workshops to discuss policies and monitor benchmark activities;
- Conducted, for the first time in Egypt, a sampling program for the water microbial features in El Salaam Canal, its feeding drains, and the effluents of the Mansoura wastewater treatment plant;
- Participated in a MOHP/WHO-sponsored wastewater irrigation training to promote public awareness;
- Conducted international study tours to Jordan (a neighboring country with an equivalent economic development level) and California, USA (renown for its stringent water quality standards and the most advanced wastewater treatment technology), to gain from their wastewater management experiences;
- Organized inter-ministry policy development by providing each party with policy outlines and technical discussions.

The aforementioned Activities under Phase I resulted in the development of eleven policy reforms. These eleven reforms address the following issues:

Reform Policy #1 – Prioritization of Wastewater Treatment Plants
Reform Policy #2 – Improving Performance of Existing Wastewater Treatment Plants
Reform Policy #3 – Classification of Drains with Consideration for Water Quality
Reform Policy #4 – Wastewater Irrigation and Public Health Awareness
Reform Policy #5 – Wastewater Quality and Regulatory Development
Reform Policy #6 – Separation, Classification, and Intermediate Reuse of Drains
Reform Policy #7 – Drainage Water quality Monitoring
Reform Policy #8 – Restricted Irrigation for Crop Use
Reform Policy #9 – Wastewater Irrigation for Desert Forests
Reform Policy #10- Wastewater Irrigation of Urban Green Lands
Reform Policy #11- Inter-ministerial Cooperation

EPIQ report No. 34 presents a detailed account of Phase I activities and accomplishments. After approval from the MWRI, the APRP Monitoring and Evaluation Unit and USAID reviewed the approved policy. The review resulted in agreement by all the parties that the Phase I indicator had been fully accomplished. Phase I of this benchmark was completed in December of 2000.

3 Pilot Study #1: Classification of Agricultural Drains

3.1 Background

Historically, drain water reuse management in Egypt has focused almost exclusively on quantity and salinity as principal management indicators. Under the existing management scheme, harvesting of drain water occurs when and where:

- It is hydraulically feasible; and
- Additional water resources are needed.

In the past several decades, increasing pollution from municipal and industrial activities has contaminated drains and degraded drain-water quality to varying degrees in many regions of the irrigation network. Consequently, poor drain water quality has severely limited drainage reuse efforts, as evident in the closing of six major mixing stations in the Delta region in 1996.

As drain-water reuse is mandated by Egypt’s rapidly increasing demand for agricultural water and system-wide allocation inefficiencies, more efficient and effective drain-water reuse management tools are required. Under Tranche IV, Phase I of this Program, the concept of classifying drains based upon their degree of pollution was presented as such a management tool. This concept was recommended as part of Policy Reform #6.

3.2 Objective

Pilot #1 Classification of Agricultural Drains was designed to implement Policy Reform # 6 on a pilot scale. Policy Reform # 6 states:

Separation of wastewater from agricultural drains is critical to sustain general irrigation in the Delta. Efforts in this direction, including drain function classification, intermediate drainage reuse, and wastewater tree-irrigation in the desert, should be recognized and supported.

Under Policy Reform #6 it is recommended that The MWRI, in cooperation with NOPWASD, MOHP, and local municipal authorities, should organize an overall drain classification program for the Delta. MWRI, in cooperation with local municipal authorities, should assess and implement, in steps, necessary penalties for discharging untreated wastewater into classified reuse drains and using drain water from classified discharge drains.

3.3 Project Participants

The Drain Classification Pilot Project required the collaborative participation of:

- The Ministry of Water Resources and Irrigation (MWRI);
- Egyptian Public Authority for Drainage Projects (EDADP), and;
- The governorates of Dakhalaiya, Sharkia, and Damietta.

The UDWR Working group assigned EDADP to take the lead role in implementing this pilot project.

3.4 Project Activities

Activities within the scope of the Drain Classification Pilot Study included:

- Close collaboration among MWRI, EDADP, and local governorates from conception through completion of the final report;
- Developing selection and screening methodology to classify drains in an expedient and appropriate manner, given existing limitations;
- Conducting a thorough field survey of main drains within the pilot project area, identifying sources, locations and approximate volumes of M&I wastewater and agricultural returns entering El Salaam Canal Catchment Area;
- Applying the selection and screening methodology created to classify main and branch drains within the pilot area, and;
- Compiling and submitting a final report documenting the project activities, findings, results, conclusions, implications, and recommendations.

The Final Pilot Project Report prepared by the team describes the activities and results in detail. This report is presented in full as Appendix B. This chapter summarizes that report.

3.5 Project Results

3.5.1 Developing Classification Methodology and Criteria

While a classification system based directly on water quality data would be preferred, current there is a lack of detailed water quality monitoring information in the drain system. As such, a flow-based classification scheme was developed that incorporates water quality as a function of its origin. The developed drain classification methodology considered drain-water to consist of three principal components: agricultural return flows, municipal and domestic, and industrial wastewater discharges. The flow-based methodology considers water quality based upon two fundamental assumptions. First M&I wastewater discharged to drains is of uniformly poor quality and causes surface water pollution. Conversely, agricultural return water is considered to have acceptable water quality for reuse and is therefore desirable. Based upon these assumptions, the ratio of wastewater to agricultural return water was used to calculate a drain classification index.

The formula used to calculate the drain classification index is:

$$I_C = [(Q_S + Q_I) / Q_A] \times 100$$

Where: I_C – is the classification index number
Q_S – is the daily flow of municipal sewerage discharged to the drain
Q_I – is the daily flow of industrial wastewater discharged to the drain
Q_A- is the daily flow of agricultural return discharged to the drain

EDADP Drainage Engineers and Water Quality Specialists identified three distinct drain types.

Class A Drains ($0 < I_C < 5$) are defined as drains for which no restriction to reuse and drains is considered necessary. Drains fitting into this classification contain a combined M&I wastewater contribution of 5% or less of the agricultural return flow.

Class B Drains ($5 < I_C < 10$) are drains that experience large fluctuations of irrigation return flows. During periods of high irrigation, return flows in Class B drains have acceptable water quality for reuse, however reuse of these drains is restricted during low agricultural return flow conditions, due to the decreases in the amount of agricultural run-off and;

Class C Drains ($I_C > 10$) contain M&I wastewater discharges in excess of 10% of the agricultural return flow in the drain. Reuse in Class C drains should be restricted under all flow conditions.

It should be mentioned that while this flow-based drain classification methodology provides an appropriate means to classify drains given the present monitoring limitations; such a methodology has several fundamental shortcomings. Under certain conditions, the use of the flow-based methodology can result in misclassification of drains. Three specific conditions exist under which this classification system fails:

1. A drain is receiving a significant discharge of well-treated wastewater. A flow-based classification could wrongly diagnose the drain as a B or a C Class, when it is really a "Class A" source in terms of water quality, and;

2. A drain is receiving a relatively small discharge of industrial wastewater that contains a highly toxic or extremely concentrated pollutant. Under such conditions, the drain might be classified as a Class A drain because the M&I wastes loading is small compared to that of agricultural return flow. In reality, the use of such water might have serious negative impacts on human health, agricultural productivity, and the environment.

3. A drain receives a large fraction of agricultural drainage that contains exceptionally high salinity, such as drainage resulting from "flushing" of reclaimed lands.

None of these conditions is considered present in the pilot area, however, and therefore the results obtained in the pilot program are considered valid. Any future use of the flow-based classification system described herein must undergo a similar evaluation of local conditions before being applied.

3.5.2 Field Survey

To estimate the magnitude of point source wastewater discharged in the pilot area, EDADP researchers, with assistance from local drainage engineers, conducted an extensive field survey of branch, secondary, and main drains within the project area. The objective of this survey was to identify, locate, and quantify significant wastewater inputs within the pilot study area. A detailed list of point source discharges surveyed in the pilot area is presented in Annex 1 of Appendix B. A summary of the survey findings is included herein as Table 3.1.

Table 3.1 Municipal and Industrial Wastewater Discharge Inventory Findings

Drainage Name	Total Number of Proposed WWTP Outfalls	Number of WWLS Outfalls	Number of Raw Sewage Pipes	Ave. Q_S 1000 (m^3/day)	Number of Industrial Discharge	Average Q_I 1000 (m^3/day)	Ave. Q_A 1000 (m^3/day)	TOTAL Q 1000 (m^3/day)
Hadous	62	23	248	538	3	184	6,859	7,581
Serw	12	20	40	110	0	0	2,207	2,317
Farasqour	7	3	8	67	0	0	1,099	1,166
TOTAL	81	46	296	715	3	184	10,165	11, 064

Q_S = Sewage flow Q_I = Industrial wastewater flow Q_A = Agricultural return flow

3.5.3 Applying the Selection and Screening Methodology

The developed classification methodology was applied to branch, secondary, and main drains within the pilot area. Data obtained through the field survey, along with the historical knowledge of local drainage engineers and operators, was used to insure that drains were not improperly classified due to the aforementioned shortcomings of the flow based classification methodology. A summary of the resulting drain classification is provided as Table 3.2. A detailed listing of drain classifications is included as Annex 2 of Appendix B.

Table 3.2 Summary of Drain Classification Results in West Salaam Canal Pilot Area

Drain Name	Length of Drain (Kilometers)	Daily Flow (1000 m3/day)	Index Number	Class	% Total Basin Flow
Hadous Drainage Basin					
Bahr Hadous	66	2,783	17.4	C	33%
Bahr Saft	65	3,102	10.8	C	37%
Ganabyat Al Nezam	7.4	477	2	A	5.7%
New Ganabyat Al Nezam	11.5	385	10	B	4.6%
Zorfzaki	13.5	122	8.5	B	1.5%
Left Ganabyat Hadous	8.5	434	3.3	A	5.2%
Alebedy	13.3	117	1.8	A	1.4%
Merga	6.8	75	29.3	C	0.9%
Elfrad	4.8	20	0.5	A	0.1%
Abdel Rahman	17.5	197	6.4	B	2.3%
Shalaby	21	73	0.7	A	0.9%
El Genena	17	128	0.1	A	1.5%
Upper Omom El Beheira	29	449	18	C	5.4%
TOTAL	**281**	**8,362**	***12.6**	**C**	**70%**
Serw Drainage Basin					
Upper Serw	27	650	8	B	28%
Lower Serw	19	1667	3.9	A	72%
TOTAL	**46**	**2,317**	***5.0**	**B**	**20%**
Farasqour Drainage Basin					
Farasqour	11	566	10.4	C	49%
Al Atawy	16	468	2.2	A	40%
Old Basarata	2.9	132	3.1	A	11%
TOTAL	**29.9**	**1,166**	***6.1**	**B**	**10%**

* *Indicated index was calculated by weighted average*

Table 3.3 presents a summary of drain classification results, presenting drain classes as a percentage of drain length in the overall drainage basin and as a percentage of the total flow through the basin on an average day.

Table 3.3 Summary of Drain Classification within the West Salaam Pilot Area

Drainage Name	Class A Drains		Class B Drains		Class C Drains	
	% Total Drainage Length in Pilot Area	% Total Drainage Water in Pilot Area	% Total Drainage Length in Pilot Area	% Total Drainage Water in Pilot Area	% Total Drainage Length in Pilot Area	% Total Drainage Water in Pilot Area
Hadous	20%	11%	12%	6%	47%	53%
Serw	5%	14%	8%	6%	0%	0%
Farasqour	5%	5%	0%	0%	3%	5%
TOTAL	**30%**	**30%**	**20%**	**12%**	**50%**	**58%**

Under the presently proposed management strategy, approximately:

- 2.1 BCM/year of freshwater will be supplied to El Salaam Canal by the Damietta Branch of the Nile;
- 0.4 BCM/year of drain water will be harvested from the Lower Serw Drain, and;
- 1.9 BCM/year of drain water will be harvested from the Hadous Drain.

Based upon this mixing ratio, Table 3.4 provides an estimate of the resulting classification harvest drain-water and a range of the resulting mixed water in El Salaam Canal. For the purposes of this analysis, it was assumed that the Damietta Branch of the River Nile was the equivalent of a Class A drain (wastewater is less than 5% of the remaining flow in the Damietta).

Table 3.4 Origins and Classification of Drain Water Available to El Salaam Canal

Water Source	Flow to El Salaam Canal (1000 m3/day)	% Total Flow to El Salaam Canal	Classification Index	Drain class
Damietta Branch	5,753	52%	0 - 4.9	A
Serw Drain	110	1%	5	B
Bahr Hadous Drain	5,205	47%	12.6	C
Total	**11,068**	**100%**	***6 - 8.5**	**B**

** Based upon weighted average*

The resulting classification of water in El Salaam Canal is Class B. The final classification of mixed water in El Salaam is predicted to be between 6 and 8.5, suggesting that improvements in water quality in drains feeding El Salaam will be necessary under the proposed classification methodology to provide an unrestricted supply of mixed water to the Sinai (class A).

3.6 Policy Implications

As demonstrated by the growing national water pollution problem resulting in closure of delta mixing stations, recent Egyptian history shows that water quality plays a critical role in drainage reuse management. The present MWRI decision-making framework lacks adequate tools to address and manage the effects of water pollution.

While the proposed flow-based classification system admittedly possesses several fundamental shortcomings, it represents a significant first step toward incorporating the effects of surface water pollution as a decision variable into Egypt's drain water reuse management process. Further development and, more importantly, implementation of the drain classification should therefore be encouraged.

As discussed before, the results of classifying drains in terms of water quality in the pilot area brings to light several important implications with regard to future drain-water reuse and management in El Salaam Canal. Namely, pilot project findings indicate that improvements in drain water quality will be necessary in the near future to provide unrestricted supply of Class A "high quality" irrigation water to the North Sinai Development Project. A complementary project entitled <u>Prioritizing Wastewater Treatment Plant Construction Activities</u> recommends infrastructure improvements to meet this target. The activities and subsequent findings resulting from Pilot #1: <u>Classification of Agricultural Drains</u> has immediate and far-reaching implications in regard to the existing reuse management scheme and to the future course of the evolution of drainage reuse management in Egypt.

Pilot Project #1 demonstrates that drain classification has application as:

- An analytical tool to assess the extent and magnitude of the drain-water pollution problem;
- A management tool to optimize drain-water harvesting, mixing, and allocation strategies, and;
- A predictive planning tool, to identify the need and extent of required pollution mitigation measures.

Analytical Tool

Drain classification can serve as a rudimentary analytical tool to assess the "big picture" in terms of drainage water quality. Results of the Drain Classification Pilot Study show that pollution of drains by municipal and industrial wastewater discharges has significant impact on overall quality of drainage entering El Salaam Canal. From Table 2 we see that by volume approximately 59% of all the water contained within El Salaam Catchment Area, or 50% of the drains by length, are by flow-based classification too polluted to reuse. Similarly, 12% of the water within the drainage is of marginal reuse value (Class B). This Class B drainage should only be used during periods of high agricultural return flows. Only 30%, or 1.2 MCM/day of drain-water in El Salaam Catchment Area is Class A, acceptable for unrestricted reuse.

Looking at it another way, if it were possible to selectively harvest and deliver this "Class A" drainage to El Salaam, it would constitute only 60% of the required drain water volume under the present management scheme. While the concept of selective harvesting has been considered in theory, its application in large-scale reuse schemes is limited by the sheer logistical obstacles to consolidating this water at a central location for mixing. Such is the case with El Salaam Canal, which is presently the only delivery system to the North Sinai Land Reclamation Project.

Management Tool
Drain classification has many applications as a management tool, three of which include:

1. Identifying high quality (class A) drain water and locating where the possibility of intermediate reuse exists,

2. Locating poor drain water (Class C) that should be avoided for reuse through separation if possible, or improved through better pollution management to increase the total volume of reusable drain water, and;

3. Predicting the resulting mixed water quality and identifying the need for alternate strategies for meeting water quality targets.

Direct intermediate reuse refers to the practice of applying "high quality" drain-water directly to agricultural lands without mixing. Farmers indiscriminately practice reuse of drain water directly to cropland at the local level. The MWRI does not presently condone this practice. Drain classification provides a means to identify acceptable drain water for intermediate reuse.

Approximately 1.3 BCM of Class A drainage flows each year among many dispersed drains throughout the pilot area. While the feasibility of selectively harvesting only Class A water on a large scale and routing it to Salaam Canal may be impractical, the possibility of extracting Class A drain water for localized reuse is quite realistic.

Should intermediate reuse of "Class A" drainage be encouraged? If so, drain classification could play a critical role in management of sanctioned intermediate reuse. In light of the difficulties encountered, and the costs incurred, is tail end mixing the only efficient means to recycle drain-water? Could direct intermediate reuse of high-quality (Class A) drain-water provide an effective alternative to tail end mixing? Should this practice be integrated into the overall drainage reuse strategy? These questions bring to bear an interesting argument in support for direct intermediate reuse.

In the particular case of the pilot area, we find approximately 1.3 BCM of high quality drain water could be made available each year for direct intermediate reuse. Through the Drain Classification Pilot Study, the locations of these Class A drains have been identified and mapped. Establishing sanctioned intermediate reuse along Class A drains would increase allocation efficiency, augment freshwater supply (allow more water to be routed to tail-end canals), and reduce pumping cost at downstream lift stations. In short, direct intermediate reuse has many attributes that should be considered. Drain classification plays a key role in identifying and locating these pockets of "high quality" drain-water.

Approximately 50% percent of the drainage canals surveyed in the pilot area and 58% of the total water contained in El Salaams drainage catchment were identified as Class

C. These findings indicate the need to implement drain separation if feasible or implementation of additional pollution management actions if water quality improvement is targeted.

Approximately 4 BCM/year of irrigation water will be conveyed through El Salaam Canal. Under the present drainage reuse management scheme, approximately one half of this mixed irrigation water (2 BCM/ year) will be diverted as fresh water from the Damietta Branch of the River Nile. The remainder (2 BCM/year) will be harvested from Bahr Hadous and Serw Drains.

Using weighted averages of drain classification indices, it was determined drain water harvested by El Salaam Canal has a composite index of 10.4. By classification, this water is not suitable for reuse (Class C). After mixing in a 1:1 ratio with fresh water from the Damietta Branch of the River Nile (assumed Class A Index $0< I_C < 5$), it is predicted that the resulting water will be Class B (Class Index 6 - 8.5). Following the drain classification definition, Class B water is of adequate quality only during periods of high irrigation return flow. During low flow conditions, alternative management schemes will be required to continue delivery of high-quality (class A) irrigation water through the canal.

By utilizing the drain classification methodology, it becomes obvious that alternative management schemes must be employed if the water quality target for mixed irrigation water flowing to The Sinai is to be met. Possible alternative schemes include:

- Harvesting a larger fraction of Class B water from the Serw Drain;
- Diverting a larger fraction of fresh water from the Damietta, and/or;
- Improving existing water quality with the Bahr Hadous Drain.

As previously mentioned Pilot project #2 addresses this last alternative by providing a list of WWTP construction activities to improve water quality of drain water entering El Salaam Canal.

Planning Tool

Lastly, drain classification can be used as a planning tool to identify the location, extent, and type of pollution mitigation measures required to improve drain-water quality. This application was used in the complementary study, Prioritization of Wastewater Treatment Plant Construction Activities (Pilot #2). In this application, drain classification is used as a predictive indicator in determining the effect that mitigation will have on water quality within the drainage network. This is a critically important function in terms of ongoing mitigation activities and existing budgetary constraints. Using drain classification as a planning tool allows limited resources to be implemented in a manner that will maximize their benefit when and where they are needed most, optimizing the value of WWTP investments.

3.7 Recommendations

Drain classification is a critical first step toward integrating water quality factors into drain-water reuse management in Egypt. While a flow-based classification technique offers a quick and appropriate means to classify drains in consideration of the present monitoring limitations, there exists the possibility of misclassification, as previously discussed.

However, there is an immediate need for drain classification given the significance of water quality in drainage reuse management and the severity of the growing water pollution problem. It is therefore recommended that the existing flow-based classification scheme be implemented in other regions of the country with recognition of its inherent deficiencies. In the interim, awareness of the deficiencies of the flow-based methodology should be considered when determining final classification of drains. Water quality testing should be conducted if there is any doubt of the toxicity of drain-water in a particular drain reach. Simultaneously, the present flow-based methodology should be further developed to include specific water quality indicators. The improved classification method should then be applied and replace the flow-based methodology. Drain water quality monitoring activities should be expanded as necessary to accommodate the use of the improved classification methodology.

Ultimately, classification of drains should be conducted nation-wide. A national drain classification database should be developed and maintained. This database should not be static. This database should be periodically reviewed and updated to reflect changes in drain conditions.

In the continued spirit of inter-ministerial cooperation, this database should be made available to all GOE ministries concerned with water resources management. From this database, a national drain-water reuse strategy should be developed, implemented and monitored.

Regarding pollution penalties associated with the discharge of untreated or poorly treated wastewater to drains. Four principal methods of wastewater discharge were identified through field surveys of the pilot area including WWTP out-falls, gravity sewer pipes, wastewater lift stations, and dispersed point source contributions from onsite sanitary facilities and agricultural activities.

The pollution penalties provided for under Law 48 should be applied to those contributing to these discharges as a means of enforcing compliance with the pertinent environmental law. While this is specified in the approved policy but was not implemented during the pilot study due to time constraints.

4 Pilot Project #2: Prioritization of WWTP Construction Activities

4.1 Background

Presently, there exists a need to expand and improve wastewater treatment infrastructure in Egypt. While the Republic of Egypt generates approximately 7.2 BCM of combined municipal and industrial wastewater per year, Egypt possesses no more than 56 major municipal wastewater treatment facilities, having a total capacity of only 2.3 BCM/year.

Further, many WWTPs have become undersized due to population growth and expansions in their respective service areas. These WWTPs suffer from wastewater overloading. Additionally some WWTPs are in disrepair due to a lack of replacement parts and equipment and still others lack properly trained personnel and practice inefficient O&M practices. As a result many of Egypt's WWTP treatment plants provide only primary (screening) or advanced primary (screening and settling) of wastewater they receive. Presently, many WWTPs in Egypt discharge wastewater as partially treated or raw sewage to outlying desert areas and most commonly to agricultural drains.

Discharge of partially treated or raw sewage to drains is an issue of concern since this practice degrades the water quality of the drain system. Poor drain water quality is an important issue because:

- Human contact with drain water is high, particularly where access to fresh potable water is limited or use of piped potable water is curtailed by lack of, or problematic sanitary drainage;
- Drain water is reused to supply agriculture through either direct intermediate reuse or by indirect tail-end mixing with freshwater, and;
- Drains discharge to inland lakes, the Mediterranean Sea, to freshwater canals, or the River Nile, important sources of fisheries, tourism, and ecological diversity.

NOPWASD

The National Organization of Potable Water and Sanitary Drainage (NOPWASD) is the governing institutional body responsible for providing water, sanitary drainage, and wastewater treatment throughout the Republic of Egypt. NOPWASD was formed within the Ministry of Housing, Utilities and Urban Communities (MHUUC) in the 1980's through Ministerial Decrees 197/1981 and 30/1986.

At NOPWASD's inception, Egypt had fewer than 26 operating wastewater treatment facilities. In recognition of the monumental task set before NOPWASD, and the important need to address Egypt's growing shortfall of wastewater management infrastructure, the GOE dispersed an annual average budget of approximately 1.2 billion LE per year to this institution over the past ten years. However, this amount does not begin to address the wastewater infrastructure needs of the county as a whole. According to an assessment of the financial needs of NOPWASD, the capital costs required to meet the 2002 infrastructure construction objectives is roughly 14.8 billion LE. By 2000, NOPWASD had allocated 9.1 billion LE, leaving a required investment of 5.7 billion LE to meet the proposed financial target of 2002. To achieve this goal, NOPWASD will require roughly 2.5 times the historical annual allocation amount over the past ten years.

To maximize the impact of its limited resources, NOPWASD has focused on constructing conventional wastewater treatment facilities for the larger population centers of the country and where infrastructure capital costs per person are optimal. This capital investment strategy has permitted NOPWASD to provide service to the maximum number of people. Through these efforts, wastewater collection and treatment is now provided to as much as 55% of the urban population, and 5% of the rural communities. Currently, NOPWASD continues to expand its WWTP construction efforts with 300 facilities in various stages of construction (1999) and the proposed construction of a total of 568 plants by the year 2007. Under this plan, NOPWASD plans to provide service to 70% of the projected population by 2007. Can NOPWASD attain this ambitious goal?

Based on historical budget allocations and construction progress, it is clear that unless NOPWASD's annual budget is significantly increased, and its activities substantially accelerated, they will not. Regardless, NOPWASD must continue utilizing its resources ever more efficiently if it is to gain ground against this national shortage of sanitary services.

Presently, NOPWASD operates on a "please one, please all" policy. Specifically, NOPWASD receives an annual request of wastewater infrastructure needs from each of the 26 Governorates of Egypt. Historically, NOPWASD has spread its budget widely, attempting to meet such requests and provide as much coverage as possible.

While the existing NOPWASD allocation technique keeps the greatest number of projects in motion, unanticipated shortages in budget, and specialized construction services have resulted in project delays. As an example, NOPWASD has proposed construction of some 47 WWTP in El Salaam Canal headwaters area due to its significance as the future agricultural water supply to the North Sinai Peninsula. As of last year, twenty-one of these proposed WWTP were in various stages of construction but none are completed. Several plants are nearly completed and are only awaiting MWRI discharge permitting or specialized tunneling equipment to complete canal and drain crossings. To date, only a single WWTP (Mansoura WWTP) is operational, but is not currently meeting Law 48 discharge requirements just one year after its commissioning. Similar scenarios exist throughout Egypt. These conditions must improve to maximize the effect of NOPWASD's efforts on a national level.

4.2 Objective

Expediting the completion of wastewater treatment facilities in El Salaam Headwaters Area, in particular, is of critical interest to the MWRI, because the quality of the drainage intended to supply El Salaam Canal is being degraded by wastewater discharges. Under Phase I of this benchmark, Policy Reform #1 calls for the prioritization of wastewater treatment plant construction activities to accelerate completion time of NOPWASD projects that provide the greatest benefit to Egypt's water quality environment.

Policy Reform # 1 states that:

In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The criteria for prioritizing the construction of wastewater treatment plants should be:

- *To protect human health (mainly drinking water sources);*
- *To sustain agricultural drainage reuse; and*
- *To maintain ecological balance in lakes and on seashores.*

Under Policy Reform #1 it is recommended that NOPWASD, together with MWRI, MOHP, and EEAA, should prepare a prioritized construction and implementation plan for wastewater treatment plants for the period 2000-2007, based upon the above mentioned priority criteria, available budget, and current on-going construction activities.

4.3 Participants

The Prioritization of Wastewater Treatment Construction Activities Pilot Project required the collaborative participation of:

- The Ministry of Water Resources and Irrigation (MWRI),
- The National Organization for Potable Water and Sanitary Drainage (NOPWASD);
- The Egyptian Public Authority on Drainage Projects (EDADP), and
- The Governorates of Dakhalaiya, Sharkia, and Damietta.

4.4 Activities Undertaken

Activities within the scope of the WWTP Construction Activities Prioritization Pilot Study included:

- Close collaboration among MWRI, EDADP, NOPWASD, and Local Governorates, from project conception through completion of the final report;
- Developing a practical set of screening and prioritizing criteria for WWTP construction activities;
- Proposing realistic water quality target objectives for drains located within the pilot area;
- Reviewing the wastewater treatment facility construction activities proposed under the current NOPWASD plan.
- Prioritizing construction activities under the existing plan based on the developed screening criteria and quality targets;
- Proposing additional construction activities as required to meet water quality targets;

- Compiling and submitting a detailed final report documenting the pilot project activities, findings, results, conclusions, implications, and recommendations, and;
- Presenting the concept, criteria and methodology of prioritization before the NOPWASD/MWRI Joint Committee for agreement and approval in principal.

4.5 Results

Inter-ministerial Cooperation
Pilot Project #2 was successfully completed through the diligent collaborative efforts of the MWRI, NOPWASD, EDADP, and Local Governorates. Cooperation and sharing of project tasks was critical to completing the pilot project successfully and on time. Joint efforts between researchers and engineers from both the MWRI and EDADP were expended in data collection and interpretation, and the compilation of the resulting Pilot Project Report. Finally, cooperation among MWRI, EDADP and NOPWASD was necessary to attain agreement in principal on the results of the pilot study.

Prioritization Criteria
Criteria for prioritizing WWTP construction activities were based upon the fundamental directives established under approved Policy Reform #6 of APRP. Overall objectives for prioritizing WWTP construction activities are:

1. Protecting human health;
2. Sustaining agricultural drainage reuse, and;
3. Maintaining ecological balance in lakes and seashores.

With these three objectives in mind, five criteria for prioritizing WWTP construction activities were developed in the early stages of the pilot project, as follows.

<u>Criteria One</u> – Wastewater discharges directly into drains under, or planned for agricultural reuse.

<u>Criteria Two</u> – Construction is included in the existing NOPWASD Plan, (ie. implementation will occur in the near future).

<u>Criteria Three</u> – Focus on the most polluted and highly populated areas.

<u>Criteria Four</u> – WWTPs currently under construction or built but not operated.

<u>Criteria Five –</u> Rank facilities meeting all the other criteria in descending order of volume of reusable water gained.

Prioritization Methodology
Applying prioritization criteria for wastewater treatment construction is a five-step screening process. The selected screening methodology relied heavily on the drain classification system developed under Pilot Project #1: Classification of Agricultural Drains as a practical indicator of general water quality. For a detailed explanation of the drain classification system, please refer to Appendix B.

The screening process began with obtaining a list of all WWTPs currently in the NOPWASD annual plan. A five-step screening process was then applied as follows:

Step 1 **–** Identify and address all significant wastewater discharges degrading water quality to drains being used or planned for use as a source of agricultural irrigation water.

Step 2 **–** Rank main drains in descending order of pollutant discharge contribution and potential volume of drain water reuse gained through treatment of M&I wastewater discharges.

Step 3 – Within the Step 2 ranking, select all WWTPs with design capacity of 10,000 cubic meters per day. Rank these according to capacity.

Step 4 – Estimate the effect of treatment that will be realized from the successful operation of each listed WWTP using the drain classification index. Assume that full treatment capacity of the treatment facility is utilized, and that the resulting WWTP effluent will meet Law 48 discharge requirements, thus resulting in a “high quality,” Class A effluent. Based upon the reclassification results, add the total water gained for reuse according to the change in classification. For example, a change from a C drain to an A drain results in a gross increase in reusable water, both during high and low flow conditions. By contrast, a change from a C to a B class results in a gain only during high flow periods, since the use of Class B drainage is recommended only when the fraction of agricultural drainage is large in comparison with the wastewater discharge. Those WWTPs that resulted in a significant change in drain classification were grouped as Step 3 selections. Those improvements that did not impart a change in drain class were dropped from the list.

Step 5 – Candidates selected under Step 4 were further prioritized in descending order with regard to the volumetric gain in reusable drain water.

Water Quality Objectives for El Salaam Canal:
El Salaam Canal project is a key focus of the MWRI’s strategy and is the most significant on-going irrigation expansion project currently underway in the Delta region. El Salaam represents not only a large addition to the East Nile Delta irrigation reuse system and a significant investment on the part of the GOE, but more significantly, completion of El Salaam marks the first time in the history that Delta irrigation water has flowed in the Sinai.

Concern exists that mixed drain water of low quality may convey pollution to this environmentally sensitive region. As the Northern Sinai is presently without significant pollution, poor quality irrigation water could negatively impact expansion efforts, since certain pollutants are known to limit agricultural production and many impart potential human and environmental health risks.

Based upon this premise, the water quality objective for the Pilot Area is to insure that water transported through El Salaam Canal is of Class A, so as to minimize adverse human and environmental effects on newly reclaimed lands on the North Sinai Peninsula. For practical purposes, high quality irrigation water is assumed to be the same as Class A drain water as developed under Pilot Project #1 (Classification index less than 5). The water quality target for El Salaam Canal is therefore a classification index less than 5.

Prioritization of WWTP Construction Activities in the Pilot Area

Utilizing the existing NOPWASD construction activities list, MWRI and EDADP researchers and engineers applied its screening and selection methodology to prioritize construction activities within the West Salaam Drainage Catchment Area. A listing of WWTPs necessary to improve mixed water quality in El Salaam Canal from restricted reuse (Class B) to unrestricted reuse status (Class A). These projects are considered by the MWRI to be of highest priority in terms of facilitating drain-water reuse in the Salaam Canal. Completion of these projects in compliance with Law 48 discharge requirements is assumed to result in effluent of Class A. The following example presents the development of the high priority list employing the screening methodology developed.

Water Quality Target – Improve mixed water quality in El Salaam Canal from Class B (restricted reuse) to Class A (unrestricted reuse).

Apply screening criteria to NOPWASD WWTP Construction List;

1. Step 1 – All drains within the pilot area are planned for use as an agricultural water supply.
2. Step 2 – In concurrence with previous findings, the Bahr Hadous Drainage was decidedly the drainage of first priority since it provides 71 percent of the flow by volume to El Salaam Canal and receives more than 722,000 cubic meters per day of combined M&I wastewater, giving the drainage as a whole a classification index of 12.6 (Class C).
3. Step 3 – Within the Bahr Hadous Drainage there are 27 WWTPs with capacities over 10,000 m^3/day.
4. Step 4 – An estimate of the effect of treatment realized from the successful operation of each of the 27 large WWTPs was conducted using the drain classification index. Those WWTPs that resulted in a significant change in drain classification remained on the recommended list of prioritized construction activities. Those improvements that did not impart a change in drain class were dropped from the list.
5. Step 5 – Candidates selected under Step 5 were further prioritized in descending order with regard to the positive water quality impact realized and volumetric gain in reusable drain water.

A final summarized list of recommended high priority construction activities for the Hadous Drainage is presented as Table 4.1. All the priority projects are currently under construction. Completion of these “high priority” projects at the earliest possible date is recommended. WWTP construction activities included on this list are necessary to improve the water quality of El Salaam Canal to a level acceptable for year-round water supply. Comprehensive prioritized lists of recommended construction activities through the year 2007 for all three major drainages within the Pilot Area are presented as Annex 4 of Appendix B.

Table 4.1 High Priority WWTP Construction Activities for Hadous Drainage

Priority	WWTP Capacity (m^3/day)	WWTP Name	Drain Class Before	Drain Class After	High Quality Drain Water Gained		Total Capital Cost (Million L.E)	Cost Remaining (Million L.E)
					Low Flow 1000 (m3/day)	High Flow 1000 (m3/day)		
1	20,000	Dekernes	C	A	37	37	80	23
2	10,000	San El Hagar	C	A	23	23	40	16
3	20,000	Abu Kbeer	C	B		23	60	20
4	20,000	El Manzalla	B	A	625	625	85	25
5	10,000	Koum El Nour	B	A	263	263	34	17
6	20,000	Omm Ghnam	B	A	259	259	75	31
7	10,000	El Walaga El Omomy	B	A	185	185	48	3
TOTAL	**110,000**	**Bahr Hadous Drain**	**C**	**B**	**1,392**	**1,415**	**422**	**135**

4.6 Presenting Recommended Prioritization Plan to NOPWASD

At the completion of Pilot Project #2, EDADP representatives submitted a final Pilot Project Report documenting the activities, findings and recommendations after review of the benchmark working group. The resulting prioritized list of WWTPs for the West Salaam Canal Drainage Area was presented to NOPWASD at their quarterly organizational meeting. Upon receiving the proposed prioritization methodology, NOPWASD agreed that efforts must be taken to expedite completion of its ongoing projects. Prioritization in principal would help to realize this end. NOPWASD agreed in principal that prioritization of its activities is necessary and the MWRI/ EDADP prioritization methodology would be considered for integration into NOPWASD's existing management framework. Detailed minutes of this meeting between representatives of the benchmark working group and NOPWASD's Deputy Chairman, documenting the concurrence of NOPWASD, is presented as Annex 6 of Appendix B.

4.7 Policy Implications

Prioritization of WWTP construction activities to achieve specific drain water quality targets provides two major benefits.

1. Focuses and streamlines NOPWASD's construction cost in an equitable and unbiased manner to expedite completion and commissioning of the most important WWTPs.
2. Maximizes human and environmental benefits gained through NOPWASD's efforts.

4.8 Recommendations

1. Prioritization of wastewater treatment plant construction activities with consideration to drain water quality should be welcomed by NOPWASD and integrated into their decision-making framework. WWTP should utilize the proposed screening methodology as a basis for further development. Furthermore, NOPWASD should:

   - Commission plants completed but not operated;
   - Finalize completion of WWTPs partially constructed;
   - Provide budget for the construction of WWTPs to serve large population centers and WWTPs providing treatment to wastewater discharges close to drainage reuse mixing stations, and;
   - Consider extending existing collection networks to accommodate larger wastewater discharges currently in the service areas but not connected to the collection network.

2. NOPWASD should work closely with MWRI, MOHP, and EEAA when developing its future project agenda to insure that the concerns of the three ministries are considered and addressed in the best manner possible. Future wastewater construction activity schedules should focus on completion and commissioning of facilities rather than initiation of new construction. Future WWTP construction lists should strive to:

   - Provide sanitary drainage service to the greatest number of people;
   - Protect human health and the environment, and;
   - Support drain-water reuse efforts.

3. Prioritization efforts should be expanded to other regions beginning with those areas critical to future drainage reuse strategies.

4. NOPWASD should allocate enough budget to cover costs of operation and maintenance of plants currently under operation until such time as the governorate economic authorities are able to do so and support continued WWTP operations personnel training, to ensure that commissioned WWTP are capable of continually meeting Law 48 discharge standards

5 Pilot Project #3: Urban Green-lands Irrigation

5.1 Background

Presently in Egypt, untreated domestic, municipal, and industrial wastewater is commonly discharged to the agricultural drain system. Discharge of partially treated and raw wastewater in this manner:

- Pollutes the Country's surface waterways,
- Imposes increased human and environmental health risks, and;
- Limits ongoing efforts to reuse excess drain water.

Untreated wastewater contains harmful pathogens, excessive macronutrients and in some cases toxic heavy metals and hazardous chemicals associated principally with commercial and industrial activities. However, properly treated wastewater represents a significant water resource to an arid country such as Egypt.

While unrestricted use of wastewater in agriculture imposes potential risks to farmers, field workers, and to consumers of food and fiber crops, restricted use of wastewater as an irrigation source for non-food crops offers many advantages including:

- Exhausting the wastewater supply before it is introduced into the drain system;
- Saving freshwater by augmenting freshwater irrigation;
- Reducing drain-water pollution;
- Cultivation of non-food goods such as timber trees in desert areas,
- Expanding biodiversity, and;
- Creating much-needed urban green lands.

Under Phase I of this benchmark, Policy #10 was approved. This measure advocated the use of treated wastewater for the irrigation of urban green lands as one possible means to utilize this non-conventional water resource.

5.2 Objective

Policy Reform # 10 states: *Use wastewater effluents to grow green lands in cities and towns in the Delta.*

As a pilot demonstration of Policy Reform #10, the Afforestation Department of MALR, in cooperation with MWRI and Dakhalaiya Governorate, conducted a limited program to use treated wastewater effluent to grow ornamental trees on a section of Highway 9N in Dakhalaiya Governorate.

5.3 Participants and Project Area

The Drain Classification Pilot Project required the collaborative participation of:

- The Ministry of Water Resources and Irrigation (MWRI);
- The Ministry of Agriculture and Land Reclamation (MALR), and;
- The Governorate of Dakhalaiya.

5.4 Pilot Project Study Area

The Pilot Site selected for Project # 3 is a five-kilometer stretch of a newly refurbished highway located near Gamesa Resort City, adjacent to the new Gamesa Wastewater Treatment Facility. Figure 5.1 provides a schematic of the project area. Figure 5.2 Provides displays a photograph of the completed site.

Figure 5.1 Schematic of Gamesa Greenland Wastewater Irrigation Pilot Project Site

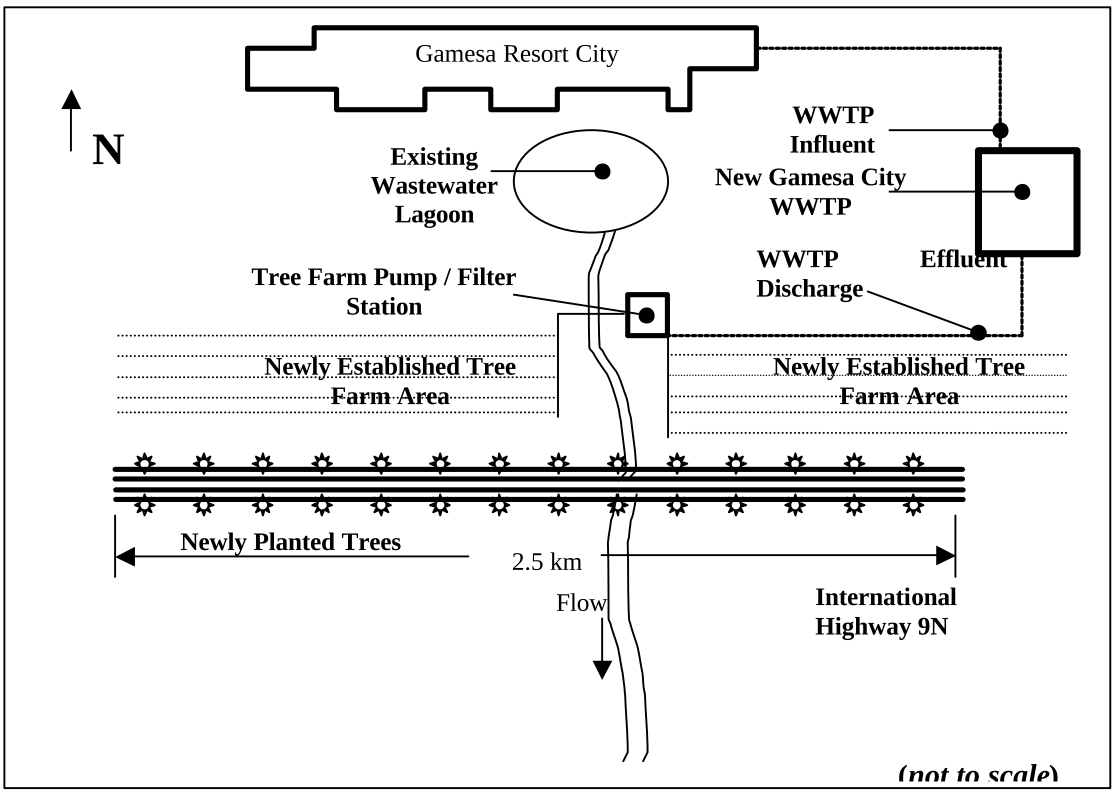


Figure 5.2 Gamesa Urban Greenland Irrigated with Treated Wastewater

5.5 Activities Conducted

Activities within the scope of The Irrigation of Urban Green Lands with Treated Wastewater Pilot Project included:

- Close collaboration among MWRI, MALR, and Governorate of Dakhalaiya;
- Selection and agreement upon an appropriate location for the pilot project;
- Design and construction of necessary irrigation infrastructure;
- Installation of the irrigation water delivery system;
- Planting and irrigation of approximately 500 ornamental trees with treated wastewater, and;
- Compilation and submittal of an Environmental Impact Assessment, and;
- Commissioning ceremony of Gamesa Urban Green Lands Pilot Area.

5.6 Results

Inter-ministerial Collaboration
Pilot Project #3 was successfully completed through the diligent collaborative efforts of the MWRI, MALR, and the Governorate of Dakhalaiya. Cooperation and sharing of project tasks was critical to completing the pilot project successfully and on time. Preparation of the final Pilot Project Report was accomplished through the collaborative efforts of MALR and EPIQ.

Pilot Area Selection

Selection of the pilot area was carried out through meetings, discussions, and site visits among EPIQ, MALR and Governorate of Dakhalaiya Representatives. Initially, a pilot site near the recently commissioned Mansoura Wastewater Treatment Facility was selected. After several site visits, however, it was realized that the Mansoura site was only marginally suitable for wastewater irrigation due to several limiting factors. Factors affecting the decision to select a second site were:

- Limited space for trees on highway shoulder;
- Adequate infiltration area near to trees was not available, and;
- Soil structure did not permit continual irrigation of wastewater.

Selection of a more appropriate pilot study area for the application of treated wastewater as an irrigation source for urban green lands, outside of Gamesa Resort City, was preferred as a large road shoulder and loosely compacted sandy soil made this site an ideal location to establish an urban green area to be irrigated with treated wastewater.

Irrigation Infrastructure

Wastewater is delivered under pressure via a pumping facility constructed for this purpose. The irrigation delivery system, of the drip emitter type, functions well with adequate pressure and well-distributed flow. Figure 5.3 shows the treated wastewater pump and filter installation used to provide wastewater to the irrigation system. Irrigation water is conveyed from the pump-station via buried 2.5 cm diameter schedule 40 pvc pipe and non-clogging drip emitters.

Figure 5.3 Pump and Filter System Urban Green Lands Wastewater Irrigation Pilot Project

Planting And Irrigation of The Demonstration Urban Green Land

Some 500 ornamental trees with an average height of 2-3 meters were planted on 10-meter centers on both sides of the highway in sandy desert soils. Treated wastewater will be supplied by a new treatment facility adjacent to the pilot study area. This facility has been constructed but has not yet been commissioned. Presently, wastewater is receiving primary treatment in lagoon areas. Effluent from these lagoons is used to irrigate roadside trees. Figure 5.4 shows the planting of ornamental trees along Highway 9N in Dakhalaiya Governorate.

Figure 5.4 Planting of Roadside Ornamental Trees at Gamesa Resort City Pilot Area

Completion Ceremony

Approximately 30 participants traveled to the site of the newly established Urban Green Lands Wastewater Forestation Project to take part in the opening ceremony of the facility in August, 2001. Governor of Dakhalaiya Dr. Ahmed S. Sawan, governorate officials, engineers and scientists, as well as representatives from MALR, EPIQ, and MWRI attended the ceremony as shown in Figure 5.5. The event received local press coverage as well as exclusive interviews with the governor and MALR project representative Dr. M. Riad by The Good Morning Cairo TV News Team (Figure 5.6). This ceremony is considered significant to the Agricultural Policy Reform Program as it symbolizes the completion of the Tranche IV, C.2 Phase II Benchmark "Green Land Wastewater Irrigation" Pilot Study #3.

Figure 5.5 Attendees at the Opening Ceremony of the Gamesa Urban Green Lands Wastewater Irrigation Project

Figure 5.6 Interview with Governor of Dakhalaiya Dr Ahmed S. Sawan and MALR Project Representative Undersecretary of Forestation Dr. Mamdouh Riad for Good Morning Egypt TV Broadcast.

5.7 Conclusions and Recommendations

Pilot project #3, Irrigation of Urban Green Lands with Treated Wastewater, successfully demonstrated that the use of wastewater for irrigation of urban green lands is a feasible practice.

Irrigation of desert tree plantations has been successfully practiced in Egypt for more than five years, confirming that wastewater can meet the biological requirements of selected tree crops. Presently, the MALR operates nine wastewater tree plantations throughout Egypt. Trees irrigated on these plantations have demonstrated impressive growth as a result of wastewater irrigation.

While wastewater irrigation of timber plantations in the desert has demonstrated the benefit of utilizing treated wastewater, the use of wastewater to irrigate urban green lands carries with it additional factors for consideration due to its practice in established or growing urban communities. Additional considerations include:

- Public exposure (human health and attractive nuisances)
- Environmental considerations (groundwater contamination);
- Site conditions (soil type, adequate buffer area) and;
- Development and selection of appropriate, cost effective methods to distribute and apply treated wastewater to urban green areas.

Based upon the outcome of Pilot Project #4, the benchmark working group recommends that the practice of wastewater irrigation of urban green lands be expanded, but only after the following conditions are met:

- An assessment of financial, socio-economic, and health implications of this practice should be conducted;
- Application of the environmental impact assessment process, and;
- A detailed design of the water conveyance system is prepared and used to determine that the project economics are acceptable.

Once siting and cost considerations have been adequately addressed, the practice of irrigating urban green lands with treated wastewater should be expanded to other areas. Care should be taken in selecting appropriate sites for this practice and consideration should be given on a case-by-case basis to ensure that each application of this practice meets all the critical site criteria.

5.8 Policy Implications

Properly treated wastewater represents a significant national water resource, especially in drier regions. Developing beneficial uses for treated wastewater is a challenging new aspect of water resource management in Egypt. Irrigation of tree crops has demonstrated measurable success in earlier MALR desert forestation projects in nine project areas throughout Egypt. Pilot project #3, Irrigating Urban Green Lands with Treated Wastewater, demonstrated that irrigation of urban green lands such as ornamental roadside trees is another effective means of utilizing treated effluent. Irrigation of urban green lands to expand green areas in and around population centers while simultaneously reducing the amount of wastewater discharged to surface waters such as drains and canals is considered a beneficial policy.

6 Pilot Project #4: Environmental Monitoring and Health Awareness

6.1 Background

The Republic of Egypt is a water-limited desert country with a population of more than 65 million people. Rapid development and population growth in Egypt over the past several decades have lead to a dramatic increase in water demand, an increase in the volume of wastewater generated, and subsequently a growing water pollution problem.

The GOE has embarked on an aggressive horizontal expansion program in an effort to increase its arable land area, to provide food, employment, and livable space for its rapidly growing population. Major horizontal expansion projects, such as El Salaam Canal Project in the Nile Delta Region, bring to bear the significance of proper water management and the need to pay particular attention to implementing adequate measures to insure the protection of human and environmental health.

MWRI has initiated several programs to meet the growing demand for water. Reuse of drain water is one key program in the MWRI strategy to meet future water demands. At present, approximately 4.5 BCM of drain water are reused. However, reuse of agricultural drain water raises concerns in regard to human and environmental health in relation to water quality, since:

- Drains are the recipients all types of wastes generated by domestic, commercial, and industrial activities, and;
- Contact (exposure) with drain water is high, particularly where adequate fresh water is limited, use of freshwater is curtailed by ineffective sanitary coverage, or when drain water is reapplied to croplands for food and fiber production.

Drains commonly receive solid and liquid wastes generated from domestic, municipal, commercial, industrial, and agricultural activities. Waste discharged to drains has a significant degrading effect on drain water quality. Principal pollutants of concern in drains include:

- Inorganic salts and nutrients;
- Human Pathogens and viruses;
- Heavy metals, toxic chemicals, hazardous waste;
- Organic and inorganic silt and suspended material, and;
- Solid refuse.

Ministerial Decree 44/2000 works together with Law 48/1982 establishing water quality discharge standards for wastewater discharge. Decree 44/2000 sets the standard of 5000/100 ml and 1000/100 ml coliform bacteria as a secondary treatment discharge standard as well as a nematode standard of 5 and 1 egg/liter for primary and secondary treatment discharge standards, respectively. Drain water most often exceeds these standards significantly.

The spread of surface water pollution and high degree of exposure by select populations through contact with drain water are two issues of concern. Irrigation managers and engineers, farm laborers, farmers, their families, and the consumer public are at risk as a result of contact with polluted drain water. Awareness of the health effects associated with wastewater and proper management practices are therefore necessary to educate and protect target populations.

6.2 Objectives

The objective of Pilot Project #4 is two-fold:

First, The Environmental Health Department of the Ministry of Health and Population (MOHP), in cooperation with the MWRI and the Dakhalaiya Governorate Authority promoted public health awareness by leading two workshops on health concerns surrounding the risks, effects of exposure to contaminated drainage and proper precautions and management practices when working with drain-water irrigation. These workshops targeted wastewater treatment personnel, health workers, and farm groups. The workshops addressed critical health issues and prevention measures for irrigation and drain management officials, and for farmers and crop handlers.

Second, In recognition of its lead role of wastewater quality inspection and regulatory development, MOHP applied Ministerial Decree No. 44/2000 by establishing specific water quality monitoring points in El Salaam Canal Catchment Area to compare critical water quality parameters against national and internationally accepted standards. The MOHP conducted one round of sampling and analysis of water samples from the selected points.

6.3 Participants

Participants in Pilot Project #4 included:

- The Ministry of Health and Population (MOHP);
- Ministry of Water Resources and Irrigation (MWRI), and;
- The Dakhalaiya Governorate Authority

6.4 Activities

Activities included under Pilot Project #4: Health Awareness included:

- Organizing and presenting a health awareness workshop to management officials;
- Organizing and presenting a health awareness workshop to farmers;
- Identifying water sampling points in El Salaam Canal, and;
- Conducting water quality analysis of one sample round from the selected points in El Salaam Canal.

6.5 Results

Health Management Awareness Workshop I (Management Officials)

This health awareness workshop was held in the Dakhalaiya Governorate on May 16-17, 2001, and was presented by Dr. Seham Mohamed Hussein – general director of the Environmental Health Department. A detailed synopsis of the workshop content and a list of attendees are included in Appendix D. The workshop training staff included:

- Dr. Seham Mohamed Hussein – general director of the MOHP;
- Chemist. Ragaa Godo Youseff – director of Wastewater Department MOHP;
- Dr. Mohamed Sayed El Gowaly. professor of Community and Environmental Health, Ain Shams University, Egypt;
- Dr. Zhongping Zhu – Senior Water Resources Engineer – EPIQ;
- Dr. Ibrahim Elassiouti – Senior Water Resource Management Specialist – EPIQ.

Participants in the workshop included managers of water, wastewater, and drainage resources:

- Engineers and managers from DEGAWS (Dakhalaiya Economic General Authority for Water and Sanitation);
- Treatment Station Operators from Mansoura, Damass, Samaha, Bermban, El Gediade, Meet Mazah, Salamoun, and Meet Damsees;
- Representatives from the Giza & Dakhalaiya Drainage Authority;
- Engineers from the Dakhalaiya Irrigation Department;
- Managers from the Dakhalaiya Environmental Health Department;
- Technicians from the Dakhalaiya Ministry of Health and Population testing Laboratories, and;
- Representatives from the Ismailia Executive Authority for North Sinai Development.

Issues presented and discussed during the health awareness workshop for managers by trainers included:

1. Dr. Seham Mohamed Hussein:
   - An overview of water resources and water management in Egypt;
   - A brief history of wastewater treatment and reuse in Egypt and other countries;
   - Strategies and priorities of environmental health management in Egypt;
   - Situation Analysis of water and sanitation services in Egypt;
   - Reuse of treated wastewater in irrigation and potential health and environmental hazards;
   - Protective measures for farmers, crop handlers, consumers, persons living near wastewater irrigated areas;
   - Egyptian Regulations in the area of wastewater reuse;
   - Law 48/1982 and Law 93/1962;
   - Ministry of Housing Decree 44/2000;
   - WHO Guidelines and the water quality standard, and;
   - The Role of Regulation in the Protection of Health and the Environment.

2. Chemist Ragaa Goda Youssef
    - The Role of Wastewater Treatment Processes in Eliminating Pollutants;
    - Physical and Chemical Properties of Domestic Wastewater and Important Water Quality Parameters: BOD, COD, TDS
    - Biological Pollutants: Pathogenic Bacteria, Viruses, Protozoa and Helminth
    - Effective Pathogen Dose and Survival Rates in Soil and Water
    - Methods of Wastewater Treatment: Primary, Secondary
    - Effects of Disinfection on Pathogen Content of Treated Wastewater
    - Advanced Methods of Wastewater Treatment
    - The Effects of Domestic Wastewater Discharges of The Fresh Water Quality of the River Nile and its Canals
    - Water Quality of Agricultural Drainage Water in Egypt
    - Organic Pollutants, Inorganic Pollutants
    - Natural Treatment
    - The Environmental Impact of Wastewater Discharge on Water Bodies in Egypt

3. Mohamed Sayed El-Gowaly
    - Health Impacts Associated With Wastewater Irrigation
    - Occupation Health Hazards to Workers in Wastewater Treatment Plants
    - Health Hazards to People in Areas Surrounding Wastewater Treatment and Disposal
    - Symptoms and Signs of the Diseases and Methods of Personal Protection
    - Protective Measure for the Community With Regard to Wastewater-Related Diseases
    - Exposure to Chemical Pollutants and Toxic Gases in Wastewater Treatment Plants
    - Occupational Protection and Personal Protection Equipment
    - Vaccination and its Effect on Protection
    - Egyptian Laws of Occupational Health

Health Management Awareness Workshop II (Farmers and Crop Handlers)
This health awareness workshop was held in the Dakhalaiya Governorate on July 26, 2001 and was presented by MOHP representative, Dr Seham Mohamed Hussein – general director of the Environmental Health Department. A detailed synopsis of the workshop's content and a list of attendees are included in Appendix D. The workshop training staff included:

- Dr Seham Mohamed Hussein – general director of the MOHP;
- Chemist. Raga Godo Youseff – director of Wastewater Department, MOHP;
- Dr Mohamed Sayed El Gowaly. professor of community and environmental health, Ain Shams University, Egypt
- Dr Zhongping Zhu – senior water resources engineer – EPIQ
- Dr Ibrahim Elassiouti – senior water resources management specialist – EPIQ

Participants in the workshop included managers of water, wastewater, and drainage resources:

- Farmers and youth graduates from El Salaam Canal Project, Sahl El Tina;

- Agricultural extension workers, Port Said Governorate, and;
- Workers from the Environmental Health Department of North Sinai Health Directorate.

Issues presented and discussed during the health awareness workshop for managers by trainers included:

1. Dr. Seham Mohamed Hussein;
   - Situation analysis of water and sanitation services in Egypt;
   - Reuse of treated wastewater in irrigation and potential health and environmental hazards;
   - Protective measures for farmers, crop handlers, consumers, persons living near wastewater irrigated areas;
   - Practices to protect health and environment in regard to wastewater and potential occupational risks, and;
   - The role of regulation in the protection of health and the environment.

2. Chemist Ragaa Goda Youssef
   - Introduction to the water resources of Egypt and the need for wastewater reuse;
   - History of wastewater reuse in Egypt and other countries;
   - Environmental health strategies in Egypt and their priorities;
   - Physical and chemical properties of wastewater and important water quality indicators: BOD, COD, TDS;
   - Biological pollutants: pathogenic bacteria, viruses, protozoa, and helminth;
   - The infective dose of pathogens and their survival in soil and water, and;
   - Group discussion about the problems facing the new communities in regard to water and wastewater-borne disease and protective measures.

Water Quality Monitoring in West Salaam Canal Pilot Project Area

Monitoring of water quality at strategic points within the drain and irrigation system provides the informational basis necessary to manage the quality of reused drainage allocated for irrigation. The Ministry of Health and Population (MOHP) is the lead agency responsible for monitoring wastewater quality. APRP Tranche IV Policy Reform #5 recommended that the MOHP take a more active role in fulfilling this important role and expanding its monitoring activities in drains. In response to this recommendation, the MOHP initiated water quality monitoring of the West Salaam Canal Drainage Reuse Project under Phase I of the benchmark and conducted additional sampling and testing during Phase II.

MOHP water quality monitoring technicians and engineers identified eight sampling points along the El Salaam Canal critical to overall water quality management. Sampling points selected were in similar locations as previous sampling, which facilitated historical comparison of the resulting data. Sampling locations included the two major mixing points: the intersection of the Serw Drain and El Salaam, and the confluence of the Bahr Hadous. Sampling locations were also selected before the Grand Siphon and seven kilometers after the Grand Siphon. During the summer months of June and July 2001 the MOHP collected and analyzed 11 drain water samples from eight pre-selected sampling points in El Salaam Canal. Sampling points were located:

- At the Mansoura Wastewater Treatment Facility Outfall;
- At the Beginning of El Salaam Canal;
- After Farasqour Mixing Point;
- After the Serw Mixing Point;
- After the Hadous Mixing Point;
- Before the Grand Siphon;
- Directly after the Grand Siphon, and;
- Seven Kilometers after the Grand Siphon.

Samples were analyzed for physical, chemical, and biological water quality parameters. Analysis conducted included:

- Total, fecal, and streptococcal coliform bacteria;
- Salmonella and viral cholera;
- Microscopic analysis including worm (helminth), protozoa, and algae, and;
- Physical analysis including temperature, hydrogen ion concentration (pH), conductivity, dissolved solids, suspended solids, dissolved oxygen, and chemical and biological oxygen demand (COD/BOD).

6.6 Results of Water Quality Analysis

Results of water quality analysis provide a typical “snap-shot” of the water quality of El Salaam Canal. A comparison of physical analysis results of samples collected in June and July of 2001 with similar samples collected the year before is summarized in Table 6.1. A comparison of bacteriological analysis results from samples collected in June and July of 2001 with similar samples collected the year before is summarized in Table 6.2. A comparison of microscopic analysis results from samples collected in June and July of 2001 with similar samples collected the year before is provided in Table 6.3. Official laboratory result sheets are provided in Annex 2 of Appendix D.

Table 6.1 Results of Physical of El Salaam Canal

Sampling Point	Temp		pH		Cond.		T.D.S		S.S		D.O		COD		BOD	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Mansoura WWTP		27		7.3		856	570	540		98		0.8	43	133	33	111
Beginning Salaam Canal		30		7.0		342	242	272		4		6.2	24	32	10	10
After Farasqour Mixing		26		8.0		1170	812	825		49		3.2		37		25
After Serw Mixing		35		8.2		640	408	332		28		4.6	23	21	18	15
After Hadous Mixing		30		7.0		580	1141	452		16		5.3	37	30	22	18
10 km Before Grand Siphon		31		4.8		2050		990		64		4.8		48		22
Immediately Before Grand Siphon		30		7.9		1534	514	740		340		4.2	19	51	14	23
Immediately After Grand Siphon		30		7.2		1030		526		194		4.5		54		18
7 km After Grand Siphon		30		7.0		2070		1070		182		4.0		125		38

Table 6.2 Results of Bacteriological Analysis of El Salaam Canal

Sampling Point	T.Col.	F. Col.	Strep	Salmonella	V. Cholera
	2001	2001	2001	2001	2001
Mansoura WWTP	7.9E+05	4.9E+04	130	nd	nd
Beginning Salaam Canal	4.9E+04	1.7E+03	30	nd	nd
After Farasqour Mixing	1.7E+05	1.7E+04	50	nd	nd
After Serw Mixing	7.9E+04	2.8E+04	40	nd	nd
After Hadous Mixing	4.9E+04	4.9E+04	20	nd	nd
Immediately Before Grand Siphon	2.2E+03	2.3E+02	50	nd	nd
Immediately After Grand Siphon	3.5E+03	2.7E+02	50	nd	nd
7 km After Grand Siphon	7.0E+02	1.3E+02	40	nd	nd

nd – non detect

National & International Standards

Fecal Coliform Standards

Law 48	< 5,000/100ml
Egyptian MOHP 2000	< 1,000/100ml
WHO 1989	< 1,000/100ml

Intestinal Helminth Standards

Law 48	no specification

Egyptian MOHP 2000

Primary Treatment	< 5 eggs/ liter
Secondary Treatment	< 1 eggs/ liter

WHO 1989	< 1 eggs/ liter

Table 6.3 Results of Microscopic Analysis El Salaam Canal

Sampling Point	Ascaris		Taenia		Hook Worm		Hymenolepis diminuta		Hymenolepis nan		Capollaria		Schistosomia		Trichuris		Paragonimus	
	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001	2000	2001
Mansoura WWTP	48	36	72		24	24	48	12	nd	36	24	24	24	12	nd		nd	
Beginning El Salaam Canal	60	36	30			24	30		nd	30				12			60	
After Farasqour Mixing		120		24.0		72		96		36				24				
After Serw Mixing	720	24	360		720				nd		nd		nd		180	12	nd	
After Hadous Mixing	720	36	360		720				nd	36	nd		nd		180	12	nd	
10 km Before Grand Siphon																		
Immediately Before Grand Siphon	28	12	72				24		24		nd		nd				nd	
Immediately After Grand Siphon		nd		nd		nd		nd		nd		nd		nd		nd		nd
7 km After Grand Siphon		nd		nd		nd		nd		nd		nd		nd		nd		nd

nd – non detect

Water quality analysis of samples collected by MOHP during the months of June and July 2001 reveal that drains discharging to El Salaam Canal impart a pronounced negative water quality impact. Analysis of Mansoura WWTP effluent identifies at least one major contributor to poor water quality. Comparisons between similar analysis conducted on samples collected from the effluent outfall of Mansoura WWTP approximately one year apart show that while the WWTP provided effectively treated wastewater in 2000, results from 2001 indicate that the plant is no longer meeting applicable discharge regulations. Recent samplings indicate that the plant is no longer providing sufficient treatment. Fecal coliform counts exceeded upper limits set by both the MOHP Law 44/ 2000 and 1989 WHO standards. Helminth counts greatly exceeded all pertinent standards. These results point to the need for continued monitoring and enforcement of discharge standards at wastewater treatment plants. Action must be taken to ensure that WWTPs continued to meet legal discharge standards.

In general, while water quality measured in El Salaam Canal revealed that the effects of poor water quality are certainly measurable; presently, pollution is assimilated over its distance of travel to the Sinai. By the time drainage reaches the Grand Siphon, it is of acceptable quality in terms of human health indicators for irrigation. Bacteriological and microbial pathogen levels meet Egyptian and WHO standards by the time drainage reaches the Grand Siphon. In fact, helminth is not detected after the siphon at all. This is an interesting observation since samples taken from the beginning of the canal were found to contain significant helminth eggs (Safaris 30/liter). There is no established scientific explanation for this phenomenon though perhaps salinity and the resonance time in the Canal may have a positive effect on helminth attenuation in the sediments or an effect of the die-off of helminth eggs before reaching the Sinai. Further investigation of this phenomenon is necessary to determine the fate of this pathogenic organism.

6.7 Recommendations

Participant feedback from the two workshops indicated that understanding of the risks and mitigation measures available for those who work with, or utilize treated wastewater is limited. Moreover, the participants indicated that the workshop content was beneficial for them. The workshop results confirmed that public awareness and education are important components of proper management practices and protection measures necessary to minimize inherent risks associated with wastewater treatment and reuse. It is therefore recommended that public awareness and education efforts propagating the best management practice for wastewater reuse and protective measures for health protection from wastewater-related disease be continued and expanded. MOHP should take the lead role in this endeavor but should continue to involve the MWRI and EEAA in developing and administering a national public awareness campaign addressing water reuse and health-related issues.

Public awareness and education are an important component of proper management practices and protection measures necessary to minimize inherent risks associated with wastewater treatment and reuse. It is for these reasons that it is recommended that public awareness and education efforts propagating the best management practices and health protection be continued and expanded. MOHP should take the lead role in this endeavor but should continue to involve the MWRI and EEAA in developing and administering a national public awareness campaign addressing water reuse and health related issues.

Analysis of water quality testing results reveal that while water quality standards are within acceptable limits for irrigation by the time water reaches the Sinai, parameters critical to health related concerns such as coliform and helminth counts exceed legal limits upstream in El Salaam Canal. Continued water quality monitoring of wastewater discharges and drain-water quality in El Salaam Canal is necessary to:

- Insure compliance with pertinent Egyptian environmental law;
- Enforce penalties for non-compliance;
- Implement proper drain-water reuse management planning, and;
- To insure that water of adequate water quality is delivered to the North Sinai Reclamation Project.

Continued and expanded water quality monitoring of wastewater discharges and drain water quality are necessary to ensure compliance with Law 48 discharge standards, to enforce penalties for non-compliance, and to implement proper drain water reuse management planning. MOHP should therefore:

- Bolster its efforts in wastewater treatment plant monitoring in step with the expansion of wastewater treatment plant commissioning activities;
- Expand its monitoring responsibilities to include drains critical to drainage reuse, and;
- Continue to work closely with MWRI, NOPWASD, and EEAA to ensure enforcement and compliance with pertinent Egyptian environmental laws.

7 Pilot Project #5: Management of Industrial Waste in Drains

7.1 Background

The Republic of Egypt presently generates more than 10.7 BCM of wastewater on an annual basis. Industry and commercial enterprises contribute 7.1 BCM/year to this amount, two-thirds of the total wastewater of the country. While Egypt is still predominately an agricultural country, industrial development is occurring at a rapid rate. Consequently, industrial wastewater constitutes not only a large, but also growing fraction of the total wastewater volume produced.

Industrial wastes are generated by large, medium, small, and micro-scale industries. Industrial wastewater is a critical factor in terms of its impact on water quality as industrial wastes can contain hazardous or even toxic materials such as heavy metals, as well as volatile and persistent organic compounds. Such chemicals can be detrimental to human health and the environment. If discharged without pre-treatment to municipal wastewater treatment plants, industrial wastes can overload wastewater treatment plants or poison treatment systems that rely on biological processes such as oxidation ponds, and activated sludge processes. Therefore, by GOE Law 48, industries must pre-treat their wastes to meet acceptable standards before discharging to municipal sewer systems or to the environment.

Discharge of partially treated or raw industrial wastes to drains is an issue of concern since it degrades the water quality of the drain system as a whole and since:

- Human contact with drain-water is high particularly where access to fresh potable water is limited or use of piped potable water is curtailed by lack of or problematic sanitary drainage;
- Drain water is reused to supply agriculture through either direct intermediate reuse or by indirect reuse through government-operated mixing stations, and;
- Drains discharge to inland lakes, the Mediterranean sea, to freshwater canals or the Nile, important sources of fisheries, tourism, and ecological diversity.

7.2 Objective

In a continued effort to thwart unwanted industrial waste dumping in drains, Policy reform measure #3 calls for authorities to:

> *Minimize the discharge of industrial wastewater to municipal sewers and agricultural drains. Agricultural drains are not open dumping sites for industrial wastes, and pre-treatment of industrial toxic wastes at the source is a must.*

Policy Reform Measure #3 recommends that the EEAA should extend its effort of restricting industrial waste dumping in the Nile River to the agricultural drains and city sanitary sewers. New industries, either large or small, must meet the at-source treatment requirements for permitted operation. MWRI, in cooperation with EEAA and MOHP, should establish more restrictions on industrial wastewater discharge in agricultural drains.

7.3 Participants

The Management of Industrial Waste to Drains, Pilot Project required the collaborative participation of:

- The Ministry of Water Resources and Irrigation (MWRI);
- The Egyptian Environmental Affairs Agency (EEAA);
- The governorate of Dakhalaiya, and;
- Local industry representatives.

7.4 Activities

Activities within the scope of this pilot project included:

- Maintaining cooperation and collaboration among MWRI, EEAA, the governorate of Dakhalaiya, and local industry representatives from project inception through completion of the final report;
- Conducting a survey of all industries discharging wastes to drains within the study area;
- Estimating pollutant loading to El Salaam Canal Drainage;
- Developing an appropriate industrial waste management action plan;
- Composing, compiling and completing a comprehensive final report documenting the project activities, findings, results, conclusions, implications, and recommendations in the form of an action plan, and;
- A final workshop involving MWRI, EEAA, Governorate of Dakhalaiya, and local industry representatives to present the results of the Pilot Study and to discuss and amend the proposed Management Action Plan.

7.5 Results

Pilot Project #5 was successfully completed through the diligent collaborative efforts of the MWRI and the governorate of Dakhalaiya. Cooperation and sharing of project tasks was critical to completing the pilot project successfully and on time. Initial selection of the pilot area was carried out through meetings, discussions, and site visits with MWRI and governorate officials. Joint efforts between EEAA researchers and engineers from both MWRI and EDADP were expended into data collection, and the compilation of the resulting Pilot Project Report. Finally, cooperation among The MWRI, EEAA, governorate of Dakhalaiya, and industry representatives was necessary to attain concurrence in principal on the proposed management action plan.

Industry Survey

To gain a better understanding of the magnitude of the adverse impact of industrial pollutants entering drains within the project area, an assessment of the associated polluting sources was conducted.

Under this survey, the Dakhalaiya Governorate Environment Department was requested to collect data regarding the different micro, small, medium and large-scale industrial pollutant sources. Data collected through this survey included the type of industry, type of waste, an estimate of the associated annual waste discharge and its respective discharge point within the project area. Data concerning the different industries was distinguished by:

- Its geographic proximity to the drains feeding El Salaam, and;
- By the size of the industry contributing waste to the drain system.

Large Scale Industrial Enterprises
A summary of the large industrial enterprises operating in El Salaam Catchment are presented by Table 7.1.

Table 7.1 Large-Scale Industrial Enterprises Operating in El Salaam Drainage

Name of Large Scale Industry	Discharge Volume (m^3/day)	Pollution Constituents	Management Action Taken
Mansoura Drain			
El Dakhalaiya Textiles	1,000	Dies, salts, phosphates, heavy metals, cotton fibers, organic and inorganic oils and grease	The company does not comply with law 48, all the studies are done, pending financial approval
Mansoura Resins and Chemicals	500	Organic matter, phenolic and nitrogenous (urea) compounds	On-Site WWTP under construction but not operational
Misr Oil and Soap Company	1,500	Organic oils, sodium hydroxide (caustic soda), organic and inorganic dissolved solids	Treating waste on site in compliance with Law 48
TOTAL	**3,000**		
El Tawila Drain			
Delta Fertilizer and Chemical Industry	3,000	Nitrogenous compounds (ammonia, urea)	WWTP and by-product recovery unit in place and in compliance with Law 48
El Nasr Bottling Company (Coca-Cola)	900	Dissolved organic matter, salts	On-site WWTP under construction but not operational
Talkha Power Station	150,000	Petroleum products, dissolved salts, heat	WWTP for grease and oil in place and operational
TOTAL	**153,900**		

In total, only six large-scale industries (employing more than 150 persons) were found discharging wastewater to drains within the study area. While total wastewater volume generated by these industries approached 160,000 m^3/day, nearly 95% of large-scale industrial wastewater load is cooling water. Further, all large industries surveyed had in place or were constructing facilities to treat their wastewater to meet GOE Law 48 discharge requirements.

Pollutants of concern with regard to large-scale industrial wastewater discharges in West Salaam Catchment are discharges of:

- Dies, salts, phosphates, heavy metals, and organic and inorganic oils and grease from textile processing, and;

- Phenolic and nitrogenous (urea) compounds from agrochemical production facilities.

Medium Small and Micro-Scale Industrial Enterprises

Medium, small, and micro-scale industrial enterprises were found to comprise the majority of all industrial activities in El Salaam Catchment. A summary inventory of these industrial enterprises is presented in Table 7.2. Table 7.3 provides a summary of the total waste volume produced by these industries. A detailed breakdown of medium, small, and micro-scale enterprises by region and associated annual waste-load is detailed in the final report of Pilot #5, in Appendix E.

Table 7.2. A Summary of Small and Micro-Scale Industrial Enterprises Operating in El Salaam Drainage

Type of Small and Micro-Scale Industry	Mansoura	Meet Gamr	El Essen-bellawane	Bani Ebeid	Temay El Amadid	Meniat El Nasr	Aga	El Manzalla	El Azizia	El Houta, New Alexandria, Frosat, El Bousrat, El Nasiama, and Meet Salsile	TOTAL
Aluminum Recycling		16	1		30			1			**48**
Aluminum Casting	30										**30**
Animal Feed Formulation		4									**4**
Automotive Body Shops	331	25				155	43	155		25	**734**
Automotive Service Stations	1										**1**
Battery Recharging			2	2	63						**67**
Bread Bakery			10	5	10	52	52				**129**
Carpenter Shops	48		123	15		194	136	192		76	**784**
Cardboard Box Manufacture	3										**3**
Chicken Breeding and Egg Production			3	2		37				14	**56**
Chicken Processing						83					**83**
Clay Brick Making		44	44	44		34	17	18	1	18	**220**
Cotton Ginning		2				2					**4**
Dairy Plants	26		4			57		4		4	**95**
Electronic Assembly				6							**6**
Food Processing and Canning	1										**1**
Garment Manufacture	4			1		12					**17**
Gelatin Products Manufacturing						30					**30**
Glass Forming			3					7			**10**
Metal Plating	13		4	1	11			8			**37**
Metals Forming and Lathing	42		224	34	242	361	361	171	22	34	**1491**
Oil Pressing		2									**2**
Pastry, Pasta, and Ice Cream Shops	13			1				29	29	12	**84**
Plastic Manufacturing	32	54	7	7		9	29	1			**139**
Seed Milling and Hauling	38	2				14	4	70			**128**
Soap Manufacturing	3										**3**
Sugar Cane Squeezing						51					**51**
Textile and Knitting Shops	167		2				67				**236**
Tile Manufacturing	19	2	8	2							**31**
Tobacco Reforming	2										**2**
Upholstery Shops					306						**306**

Table 7.3 A Categorical Summary of Industrial Waste Volumes Generated by Medium, Small, and Micro-Scale Industries

Pollution Parameter	Total Annual Loading (Tons/Year)
Bio-degradable material	
BOD	146
Emulsified oil	20
Suspended starches	4.2
Milk fats and whey	4.0
Biodegradable oils and floating solids	3
Dissolved organics	2.0
Salts	0.21
TOTAL	**179**
Bio-degradable material	
Clays	111
Metal scrap	69
Mixed petroleum and paint products	24
Misc. suspended solids (non-biodegradable)	20
Petroleum non-biodegradable oils	17
Non-biodegradable oils	14
Solid aluminum	8.5
Non-biodegradable paints	4.9
Acids with heavy metals	1.4
Lactates from solid waste	0.04
Highly toxic matter	0.02
Heavy metals	0.01
Cyanides	0.01
TOTAL	**270**

7.6 Conclusions

Management of industrial waste discharges to drains by large, small, and micro-scale industries is a critical issue not only in considering the potential direct human and environmental consequences associated with this practice, but especially in light of Egypt's present need to reuse drain water. Pollutants of particular concern in regard to industrial wastes are:

- Macronutrients, particularly inorganic forms of nitrogen and phosphorus, which form the primary catalyst of eutrophication and can cause illness, particularly in babies and elderly persons;
- Toxic substances such as heavy metals as well as volatile and persistent organic compounds, which bio-accumulate or bio-magnify to toxic levels in the food web, and;
- Silt and suspended material (inorganic solid waste), which reduces the natural assimilative capacity of drains and can be the carrier agent for heavy metals and toxic organic compounds.

Direct risks (costs) associated with contact and reuse of drain water contaminated by industrial wastes are to the health of farm workers, their livestock, and to land

productivity. Further, the consumer public is also at risk since certain industrial contaminants may accumulate in food and fiber products to toxic levels.
In short, corrective action is necessary to control industrial discharges to drains.

Results from the industrial wastes survey conducted under Pilot Project #5 revealed several key points:

- First, the number of large industries within the West Salaam Canal is quite small in comparison to the number of small and micro-scale industrial enterprises. Hence, while discharges from individual large industries are generally much greater than those from small and micro industries, the cumulative contribution of smaller enterprises is much larger than the discharge from large industries within the pilot study area.

- Second, historically, enforcement of GOE industrial waste discharge regulations has focused mainly on large industry because these discharges are relatively large and easy to identify and it is believed that larger industries possess better access to capital and thus are more likely to implement corrective measures, and;

- Lastly, small and micro enterprises have been generally overlooked. Further, many small industries are not registered with the local government and dump their wastes sporadically and in a dispersed manner making, enforcement and accountability for industrial pollution difficult. Further, the costs of collection and treatment of wastes generated by small and micro-industries are expensive and impractical, due to the complex treatment requirements and dispersed nature of small industry.

7.7 Recommendations

In recognition of the finding of the industrial waste survey conducted in West Salaam Canal, an immediate action plan was created. Representatives of the MWRI and EEAA drafted this action plan. The plan was presented in a final workshop in Mansoura City in September 2001 and was amended to include the ideas and recommendations of the Governorate of Dakhalaiya and local industry leaders. The final action plan addresses the current issues confronting industrial waste management and the discharge of industrial wastes to drains and canals. A summary of the proposed action plan is presented as Table 7.4.

The final modified action plan proposes five major activities (management actions) to reduce industrial waste discharges from small and micro-scale industries. Activities under the modified plan include:

1. Strengthen monitoring and law enforcement actions on large-scale industries;
2. Expand the survey of small and micro-scale industries conducted in the West Salaam Canal Catchment to other areas;
3. Initiate a public environmental awareness campaign focusing on industrial waste management issues, impacts, consequences and appropriate remedial actions;

4. Develop incentives to promote compliance with established industrial waste discharge regulations and standards, and;
5. Promote the establishment and development of private and public environmental services industries.

Table 7.4 Proposed Management Action Plan for Industrial Waste Dumping in West Salaam Canal Catchment Area

	Proposed Actions	Needed Participation
1	**Strengthen monitoring and law enforcement actions on large-scale industries**	• Ministry of Environment-EEAA • Ministry of Health
2	**Survey of wastewater from medium and small-scale Industries** ▪ Investigating wastewater generation, treatment and disposal from medium and small scale industries ▪ Assessing those industries for their wastewater and hazardous wastes ▪ Developing a safeguard and practically feasible plan on medium and small scale industries wastewater treatment and disposal	• Ministry of Local Development at the Governmental level • Ministry of Environment-EEAA • Ministry of Health • Irrigation & Drainage authority • Industrial representatives
3	**A public environmental awareness campaign** ▪ Local TV programs and street posters ▪ School education and woman's leading role ▪ Awareness meeting at industry sites	• Ministry of Local Development • Ministry of Environment • NGO's • Ministry of Mass Media
4	**Compliance with the environmental pollution controlling laws** ▪ Creating measures to strengthen compliance of Law 48 and other environmental regulations ▪ Restricting penalties on unlicensed industries and preparation of new industries to the Environmental Impact Assessment ▪ Enhancing the industrial relocation program for small and medium industries within residential areas.	• Local Development authority • Industrial representatives • EEAA • Academic institutions and Ministry of Health Laboratory • Ministry of Housing and Urban Planning Institutions
5	**Promoting environmental services industry** ▪ Initiating private contractors to manage the wastewater collection, transportation and disposal services for medium and small scale industries ▪ Creating private enterprises to recycle and reuse selected components in the collected wastes and supporting them with the technologies to handle the liquid and hazardous wastes generated by small and Medium scale industries. ▪ Developing the land fill site for final wastewater treatment residues disposal	• Industrial representatives • EEAA authority • Public Health authority • Irrigation & Drainage authority • Social Funds

The proposed action plan was developed based upon the findings and conclusions of Pilot Project #5. Successful implementation of the proposed plan will require the continued collaborative efforts of MWRI, EEAA, MOHP, NOPWASD, as well as the Ministry of Mass Media, Ministry of Local Development, NGOs, and industry leaders and representatives.

There are five major components to the plan:

*1.**Strengthen Monitoring and Law Enforcement Actions on Large-Scale Industries***
Despite current efforts, the response from large industries has been more sluggish than expected, largely due to lack of adequate incentives, enforcement, and follow-up monitoring. Better incentives for compliance are needed for large industries. A detailed investigation of possible incentives should be conducted. Most importantly, adequate follow-up monitoring, and diligent enforcement to encourage continued compliance within a reasonable length of time must support these improved incentives.

*2.**Surveys of Industries and Industrial Wastes with Focus on Medium and Small Industries***
In order to develop effective industrial waste management strategies, it is important to have an idea of the type, amount and distribution of industries and their wastes. Surveys such as the one conducted under Pilot Project #5 are recommended for other regions of the Delta. Information gathered from such surveys should be entered into a comprehensive, interactive database used to plan and track industrial waste management activities.

*3.**Public Environmental Awareness Campaign***
Public awareness of the impacts of unmanaged industrial waste discharge to drains and other surface waters is an important step toward changing public behavior and realizing effective management policies. A comprehensive awareness campaign including local television and advertising, school education, and exposure of improper industrial disposal activities is recommended under the immediate action plan.

*4.**Compliance with the Environmental Pollution Controlling Laws***
Environmental Law 48 is not consistently applied and enforced. Measures to strengthen Law 48 and other environmental laws are necessary. Many industries, particularly medium, small and micro-scale are unregistered and cannot afford the costs of penalties and treatment. Incentives such as restricting penalties on newly registered industries, requiring new industries to conduct an environmental assessment before beginning operation, and industry consolidation and relocation programs should be investigated.

*5.**Promoting an Environmental Services Industry***
There is a dire need to collect hazardous wastes generated from the different micro-scale industries and reprocess them or sell them to other industrial plants to process or dispose of properly. It is also very important for the local authorities to support small entrepreneurs in collecting solid and liquid hazardous wastes and non-hazardous wastes for reutilization and reprocessing. Collection of all types of wastes emanating from the micro-scale industries will mitigate their impact on waterways, especially water drains, while passing through the urban centers.

7.8 Action Plan Acceptance

A workshop to present the findings of Pilot Project #5 and propose the recommended industrial waste management action plan was held in the Dakhalaiya Governorate Building in September 2001. During the workshop, VIP attendants including the governor of Dakhalaiya, the undersecretary, and local industry leaders enthusiastically accepted the proposed action plan. An outline of the workshop proceedings is included as Annex 1 of Appendix E. Figures 7.1 and 7.2 show photographs taken during the final workshop meeting of Pilot Project #5.

Figure 7.1 Final Pilot Project #5 workshop panel

Figure 7.2 Attendees at Pilot Project #5 final workshop in Mansoura City, September 2001

Figure 7.3 Dr. Samia Galal Saad being interviewed by local television during the final workshop of Pilot #5 in Mansoura City, September 2001.

Ministry of Water Resources and Irrigation
US Agency for International Development
Agricultural Policy Reform Program
Environmental Policy and Institutional Strengthening Indefinite Quantity Contract

APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

APPLICATION OF POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 46
Appendices

December 2001

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

List of Appendices

These appendices are individual reports prepared by the benchmark task group members from different ministries and agencies. They are bound together in one volume for convenience of access.

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Appendix A

Phase I Policy Reforms:
Eleven Reform Measures

APPENDIX A

ELEVEN POLICY REFORM MEASURES APPROVED UNDER UWDR TRANCHE IV, PHASE I BENCHMARK

1) Treatment of Wastewater

Policy #1 In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The criteria for prioritizing the construction of wastewater treatment plants should be:

- To protect human health (mainly drinking water sources);
- To sustain agricultural drainage reuse, and;
- To maintain ecological balance in lakes and on seashores.

Procedures NOPWASD, together with MWRI, MOHP, and EEAA, should prepare a prioritized construction and implementation plan for wastewater treatment plants for the period 2000-2007, based upon the abovementioned priority criteria, available budget, and ongoing construction activities.

Policy #2 An urgent need in wastewater treatment is to improve the effectiveness of those treatment plants already constructed and operational.

Procedures NOPWASD should create more educational and practical opportunities for the development of Egyptian wastewater treatment professionals. WWTP operation codes, the operator license system, and effluent quality control must be enforced. The corporation model of the Public Economic Authority, as a transition to full privatization of wastewater services, should be extended to more governorates, and a user-pays, self-reliant finance mechanism must be exercised in those authorities. NOPWASD should also strengthen public awareness education about urban wastewater services.

Policy #3 Minimize the discharge of industrial wastewater to municipal sewers and agricultural drains. Agricultural drains are not open dumping sites for industrial wastes, and pre-treatment of industrial toxic wastes at the source is a must.

Procedures EEAA should extend its effort of restricting industrial waste dumping in the Nile River to the agricultural drains and city sanitary sewers. New industries, either large or small, must meet the at-source treatment requirements for permitted operation. MWRI, in cooperation with EEAA and MOHP, should establish more restrictions on industrial wastewater discharge in agricultural drains.

2) Health Concerns and Wastewater Quality Standards

Policy #4 The primary threats of wastewater irrigation to human health are pathogenic organisms found in wastewater, including bacteria, viruses, protozoa, and helminthes.

Procedures MOHP, in cooperation with MWRI and NOPWASD, should strengthen public awareness education on the human health risks of wastewater irrigation. All cooperating ministries should establish a better understanding of the various potential mitigating measures and their applications under the Egyptian conditions. MOHP should increase its scientific research to examine human health risks from wastewater irrigation in Egypt. NOPWASD should pay more attention to the effective removal of pathogens in treatment plants.

Policy #5 The water quality requirements issued in Law 48 and MHUUC Ministerial Decree No 44/2000 represent the authorized standards in Egypt. All involved ministries and agencies should better recognize the role of MOHP in wastewater quality inspection and regulatory development.

Procedures MOHP should accelerate technical capacity building at both the national and local levels for the increasingly complicated quality monitoring and inspection tasks. MWRI should classify the Nile watercourses for different water quality standard applications. MOHP, in cooperation with MWRI and other involved ministries, should develop clear responsibility lines in monitoring wastewater treatment plants, mixing points in drains and canals, lakes and seashores, unrestricted and restricted irrigation fields, and other sites of particular interest.

3) Discharge and Reuse of Wastewater

Policy #6 Separation of wastewater from agricultural drains is critical to sustain general irrigation in the Delta. Efforts in this direction, including drain function classification, intermediate drainage reuse, and wastewater tree-irrigation in the desert, should be recognized and supported.

Procedures MWRI, in cooperation with NOPWASD, MOHP, and local municipal authorities, should organize an overall drain classification program for the Delta. MWRI, in cooperation with local municipal authorities, should assess and implement, in steps, necessary penalties for discharging untreated wastewater into classified reuse drains and using drain water from classified discharge drains.

Policy #7 The MWRI drainage-monitoring program has functioned as a main technical support in the Delta region’s water quality management during the past two decades. The program should be encouraged and continued.

Procedures MWRI, in cooperation with MOHP and EEAA, should upgrade the existing drainage monitoring program for more competent wastewater-related monitoring work.

Policy #8 Follow MHUUC Ministerial Decree 44/2000 and WHO 1989 Guidelines to initiate restricted irrigation for the safe use of wastewater on selected crops.

Procedures MALR, in cooperation with MWRI and MOHP, should plan crop zones for different quality irrigation sources in the Delta. MALR and MWRI should test pure wastewater irrigation for selected crops with cautious assessment of the possible groundwater contamination in neighboring areas.

Policy #9 Wastewater effluent irrigation on timber trees in the desert is an environmentally and economically sound reuse. The effort should be recognized, encouraged, and supported.

Procedures MALR should expand its current effort to promote wastewater irrigation of timber trees in the desert by strengthening public awareness education programs and by providing stronger economic incentives to attract private sector participation. MALR and MWRI should better cooperate to conduct environmental impact assessment, particularly groundwater impact evaluation, for wastewater irrigation in timber tree plantation.

Policy #10 Use wastewater effluents to grow green lands in cities and towns in the Delta.

Procedures The Afforestation Department of MALR, in cooperation with MWRI and Dakhalaiya Governorate, should conduct a pilot program using wastewater effluents to grow street trees in Mansoura City. The pilot work should include an environmental impact assessment.

4) Inter-ministry Cooperation

Policy #11 Inter-ministry cooperation is the foundation of the urban wastewater management endeavor. MWRI, as the national water authority, has to take the lead in developing and sustaining the cooperation.

Procedures Establish a commonly agreed cooperation framework, clarify each party’s authority and obligation lines, and establish a financial mechanism to support cooperation in water quality management.

Ministry of Water Resources and Irrigation
US Agency for International Development
Agricultural Policy Reform Program
Environmental Policy and Institutional Strengthening Indefinite Quantity Contract

APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

APPLICATION OF POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 46
Appendix B

December 2001

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

Appendix B

Drain Classification and Wastewater Treatment Plant Construction Prioritization in El Salaam Canal

UWDR Tranche IV Benchmark, prepared in fulfillment of Pilot Projects 1 and 2

By Eng. Mohamed Fathy Hassan, Eng. Adul Monien Hamza,

and Eng. Mohamed Khazragy of EPADP

Appendix B

Drain Classification & Prioritization of Wastewater Treatment Construction Activities in El Salaam Canal Drainage

Prepared by
Eng. Mohamed Fathy Hassan, Eng. Adul Monien Hamza,
and Eng. Mohamed Khazragy of EPADP

1. INTRODUCTION

1.1. Background:

The Government of Egypt (GOE) has embarked on the development of several major horizontal expansion projects (HEP) as part of the national effort to increase Egypt's arable land base and subsequent domestic food production capability. In Egypt, HEP projects typically entail converting desert "wastelands" into productive farmland. The key ingredient in the desert reclamation process is the ability to consistently provide water of adequate quantity and quality for crop production. Obtaining the necessary water for large-scale HEP's can require large and often elaborate extensions and additions to the existing irrigation infrastructure and drainage network. El Salaam Canal project in the Eastern Nile Delta, is one such challenging new HEP.

1.2. The Significance of El Salaam Canal:

El Salaam Canal project is a key focus of the MWRI and is arguable the most significant on-going irrigation expansion projects currently underway in the Delta Region. El Salaam represents, not only a large addition to the East Nile Delta irrigation reuse system and a significant investment on the part of the GOE; most significantly, completion of El Salaam marks the first time in the history of The Republic of Egypt that delta irrigation water has flowed in the Sinai.

1.3 Physical Layout of El Salaam:

By design, El Salaam mixes fresh Nile water with drain water harvested from three major drain systems in the Eastern Nile Delta. The intake of El Salaam begins at Damietta Branch of The River Nile, 219 kilometers west of The Suez Canal. It first flows first northeast towards Lake Manzalla but veers to the East before meeting the Lake where it meets with Serw Drain. The Salaam Canal then flows southeast where it joins the confluence of The Bahr Hadous Drain. Finally, water is conveyed under the Suez Canal through "The Great Siphon" , located some 28 kilometers south of Port Said, to the North Sinai Peninsula. Water emerges from the siphon on the Sinai Peninsula as El Sheikh Gaber El Sabah Canal; bringing water to El Areesh Valley. Figure 1 provides a schematic layout and map of El Salaam Canal Irrigation Scheme.

1.4 Present Management Scheme:

Under the presently proposed management scheme, water from the aforementioned three drains will be mixed with fresh water from the Damietta Branch of The River Nile in a ratio of one part drain water to one part fresh water. Drain water supplied to El Salaam Canal will be 2 BCM/year. This implies that another 2 BCM fresh water must be withdrawn from Damietta

Branch of the River Nile annually. Together, this water (4 BCM) will supply irrigation water to 200,000 feddan on the western side of the Suez Canal region, and 440,000 feddan in the East, north of Sinai Governorate

1.5 Pollution Sources:

As the Northern Sinai is presently without significant pollution, concern exists that mixed drain water of low water quality may convey pollution to this environmentally sensitive region. Further, poor quality irrigation water could negatively impact expansion efforts since certain pollutants are known to limit agricultural production and many impart potential human and environmental health risks.

Concerns are realized by the fact that irrigation drains are commonly the receiving waterways of municipal and industrial wastes (M&I) in addition to agricultural run-off. Discharges of partially treated and untreated (M&I) wastewater in drains is of extreme concern in light of the current drain water reuse policy because:

Of the negative human and environmental health risks associated with both direct and indirect exposure to pathogens and toxic pollutants, and;
The deleterious effects that such pollutants have in agriculture.

Water quality is of great concern with regard to El Salaam since the Sinai is relatively free of the pollution and potential waterborne diseases associated with poor drain water quality. If not properly managed, El Salaam Canal could become a major pollutant conveyance mechanism impacting the future development of this important HEP. Therefore, it is critical that water pollution and its associated negative potential impacts are minimized in mixed irrigation water before it reached El Sheikh Gaber El Sabah Canal.

Pollution received by the agricultural drains, and to a lesser degree canals supplying El Salaam can generally be categorized in terms of its method of dispersion. Pollution can enter surface waterways as point (piped M&I wastewater out-falls), dispersed point (onsite domestic waste and septic pump truck), and non-point (surface runoff) source contaminates. The Salaam Canal Drainage area is not unique in this regard. Pollution in the form of:

- M&I wastes are discharged as piped out-falls, villages discharges discharge;
- Domestic wastes both through dispersed single piped discharges and well as seepage and overland flow, and finally;
- As collected agricultural surface runoff and subsurface seepage

Are presently degrading the water quality to varying degrees throughout El Salaam Catchment Area.

Municipal and Industrial Wastewater discharges pose impart perhaps the heaviest negative impact on the water quality of drains. Egypt as a country produces and estimated 11.7 BCM/year of M&I wastewater. The Delta Region alone generates more than 2 BCM/year most emanating from Egypt's two greatest urban centers, Cairo and Alexandria. The vast majority of this waste is discharged to the drain system either raw or only partially treated. M&I wastewater is discharged to drains through gravity flow pipes, by pump-stations, through dispersed point sources, and overland flow. Figure 1 depicts an example of M&I discharge in the pilot study area.

Figure 1 M&I discharge in the pilot study area.

1.6. Problem Statement:

Given the present plan to utilize drain water from El Salaam Canal, it is critical that drain water be managed to minimize the associated potential impacts of water pollution. El Salaam will require more extensive treatment coverage thus ultimately equating additional investment not only infrastructure, but also in operation, maintenance and training. While managing drain water pollution is not a simple or in-expensive task; it will be necessary if water quality to is to satisfy the productivity expectations of El Salaam Canal.

Under the ongoing Agricultural Policy Reform Program (APRP) the MWRI is addressing the issue of drain water quality improvement by investigating appropriate and sustainable ways to control the pollution of drains, and by developing policy to implement appropriate drain water pollutant management tools. Under the APRP eleven policy reforms were developed and approved by the MWRI. Approval of these policies has lead to the implementation of pilot

projects to test the appropriateness and in some cases feasibility of the policy reform.

Two of these pilot projects set out to test Policy reforms:

Number one; prioritization of wastewater treatment construction activities, and Number six, classification of drains according to their reuse potential.

Objective Statement**:**
Development of pilot projects to demonstrate policy reform number one and six are required under Tranche IV Phase II of the APRP. Classification of drains and prioritization of wastewater treatment facilities construction are two management tools necessary to insure necessary water quality in El Salaam Catchment Area. Development an implementation of pilot studies to test these reforms is therefore the objective of this report.

The Egyptian PA Drainage Projects (EPADP), in cooperation with MWRI and Dakhalaiya Governorate, successfully completed two related pilot studies designed to test the recommended policies and procedures resulting from APRP Phase I.
Objectives of these related studies were to two-fold:

- UWDR Bench Mark for Pilot Number One

The objective of Pilot Project Number One was to create and apply an appropriate classification scheme for drains in the West Salaam Drainage Area. Drain classification is intended to serve to reflect general water quality and the level of reusability of main and branch drains in the West Salaam Drainage Catchment. Ultimately drain classification is intended to provide a definitive water allocation management tool to aid in the management of both the quantity and quality of reused drain water. Completion of the Drain Classification Activity will be marked by successful demonstration of the Classification Methodology within a pre-defined pilot study area.

- UWDR Bench Mark Pilot Number Two

The objective of Pilot Project Number Two is to develop a Prioritized List of wastewater treatment plant construction activities. Ideally, this prioritized list would fall within the existing NOPWASD plan. A prioritization of ongoing construction activities is intended to focus limited resources on projects already within the existing NOPWADS Plan to maximize the anticipated cumulative positive water quality impacts associated with NOPWASD Efforts. It is intended that appropriate prioritization methodologies will benefit mutually The MWRI and NOPWASD. Completion of this Benchmark activity is to be marked by NOPWASD's recognition and concurrence in principal with the WWTP Construction Prioritization Methodology during the final "round-table meeting among NOPWASD, MWRI, and EPADP representatives.

1.7. Pilot Project Activities:

The study detailed in this report examines M&I pollutant discharges in the West Salaam Canal Drainage Area inclusive of the Bahr Hadous, Lower Serw, Upper Serw, and Farasqour Drainage Areas. For logistical purposes, pilot activities proposed to test Policy reforms one and six were combined into one project conducted through the collaborative efforts of The MWRI, the Governorate of Dakhalaiya, and EPADP. Activities within the scope of this study included:

Pilot #1

- Developing selection and screening criteria to classify the level of reusability of sub-drains of El Salaam Canal;
- Identifying sources of pollution entering the drain system feeding El Salaam Canal;
- Quantifying the pollutant contributions of M&I Waste discharges and their location in El Salaam Catchment Area.
- Applying the selection and screening methodology created to classify main and branch drains within the pilot project area.

Pilot #2

- Propose realistic water quality target objectives for drains located within the pilot area;
- Review the wastewater treatment facility construction activities proposed under the current NOPWASD Plan.
- Prioritize construction activities proposed under the existing plan based the established quality targets, and lastly;
- Propose additional construction actives as required to meet water quality targets.

2. DRAIN CLASSIFICATION:

2.6. Why Drain Classification?

Drain classification is an important management tool and a critical element of the previously recommended DSS. Classification of drains in terms of water quality provides a means to protect human health and optimize reuse drain water quality. This is of critical importance since:

- Human contact with drain water is known to be high particularly in the rural setting and where fresh water is unavailable or in short supply, and;
- Because often drain water is reused to irrigate food crops.

2.2 Ideal Classification and Management:

Ideally, classification of drains and for that matter drain water quality management should be dynamic. Drain management should be able to respond quickly to changes in within the system such as: water quality, mixing ratio, pollutant discharge; changes in natural assimilation, seasonal demand, and cropping pattern, not to mention available supply or consumption patterns, etc. A dynamic and integrated management system represents perhaps the most sophisticated and encompassing management method. Such a system would require extensive and continual monitoring as well as highly integrated institutional cooperation. Though significant progress is being made, presently The Republic of Egypt does not currently possess the necessary monitoring capability, enforcement power, nor the institutional cooperation necessary to implement or administer a dynamic, integrated water quality management system. These necessities must evolve over time and be build upon a solid technical and institutional foundation. Further, there is limited budget to address rapidly spreading environmental degradation caused by M&I Waste discharges

2.3 Realistic Classification and Management:

Currently there is a lack of adequate water quality data collected for drain water. While monitoring of basic quality parameters is conducted at many of the large reuse mixing stations, very little in depth water quality analysis is conducted on a scheduled basis and virtually no monitoring is conducted on smaller secondary, branch and *mesqa* drains where the vast majority of pollutant discharge occurs. In light of the existing circumstances, a simplified water quality management scheme is deemed appropriate. A method that considers pollutants as grossly categorized by their source and origin namely: irrigation return, municipal wastewater, and industrial wastewater was proposed as one means to make the distinction. Between drain water that: can be reused under any condition, reused under specific conditions, and drain water that should never be reused. While flow based classification offers a simple and effective means to categorize drains, there are two critical theoretical shortcomings to such a classification methodology in which drains may be inadvertently misclassified. The first situation exists when a drain receives a large fraction of highly treated M&I wastewater. In this case the flow based classification methodology would label this drain as a B or C class drain when in reality its water quality might make it quite acceptable for unrestricted reuse (Class A). The second an perhaps more serious case of misclassification occurs when a very small but highly toxic waste is discharged to a drain. Under this scenario the flow-based methodology will categorize the drain as acceptable for reuse when in reality water in the drain is of very low quality. As such, a flow-based methodology should be applied with great care and its results should be considered on a drain by drain basis.

2.4 Drain Classification Methodology:

Keeping in mind the existing monitoring and staffing limitations, it was agreed among EPADP's engineers to utilize a flow based classification methodology. The formula used to create this classification is a simply ratio of pollutant flows to agricultural flow. In this way, the main four drains within and their branches can be categorized to three main class according to the following equation:

$$S = [(Q_S + Q_I)*100] / Q_A$$

Where: S = Classification Index
Q_S = Sewage discharge;
Q_I = Industrial discharge, and;
Q_A = Agricultural discharge.

From this equation, three distinct drain classifications were made:

Class A Drains are defined as drains for which no restriction to reuse exist ($S<5$ %).
Class B Drains are restricted only during low-flow conditions but may be utilized when significant irrigation return flow is present ($5 > S > 10$), and;
Class C Drains are unconditionally restricted during all flow regimes ($S >10$).

3 WWTP CONSTRUCTION PRIORITIZATION

3.1 Existing Plan:

Presently the Republic of Egypt is developing and expanding its severely limited sanitary coverage. To provide an idea of the magnitude of this present wastewater treatment shortfall, consider that in a country of some 68 million

people, it is estimated that only 50% of the urban population is accessed by a sanitary collection network while in the rural sector less than 5% receive such service. Consider further that the country's population adds approximately 1one million people every nine months.

Under the auspices of the Ministry of Housing and Urban Settlement, The National Organization of Potable Water and Sanitary Drainage (NOPWASD) is bestowed with the daunting task of constructing wastewater treatment facilities and sewage collection systems nation-wide. In response to annual request for treatment facilities at the governorate-level NOPWASD allocates its annual construction budget. Historically, NOPWASD has spread its budget widely attempting to provide as much coverage as possible.

3.2 Why Prioritize Construction Activities:

While the existing NOPWASD allocation technique keeps the greatest number of projects in motion, shortages in project budget and in some cases difficulties encountered in obtaining a discharge permit, or specialized construction services have resulted in project delays and incompletion. This claim is well supported by historical evidence. When NOPWASD was conceived in 1982 Egypt possessed some 28 wastewater treatment plants. Over the past ten years NOPWASD has received an annual average budget allotment of 1.2 billion Egyptian pounds. As of the year 2000 there were 56 WWTP's in operation nation-wide but as many as 300 in various stages of completion. More specifically, in recognition of the significance of El Salaam Canal, NOPWASD has proposed construction of some 47 WWTP within this critically important drainage. As of last year 1999, 21 of these proposed WWTP's were constructed but not operated. To date a single WWTP (Mansoura WWTP) is operational and recent water quality monitoring of Mansoura's effluent bring into question it treatment effectiveness (MHOP data 2000).

Development of a politically unbiased prioritization methodology for WWTP construction activities is necessary expedite the completion of WWTP and maximize drain water quality improvements results from completed WWTP's. Prioritization of WWTP construction activities is intended benefit both NOPWASD and the MWRI by providing NOPWASD with a methodology for improving its performance by expediting completion of existing works while simultaneously maximizing the positive impact to receiving drain water quality.

Prioritization Criteria:
Drain classification methodology was based upon four governing criteria:

Criteria One – All activities to be prioritized must already be included under the existing NOPWASD Plan. This first criteria is intended to support NOPWASD's existing activities and insures that further prioritization in no way usurps the mandate or authority of NOPWASD.

Criteria Two – Maximize NOPWASD's positive impact on human and environmental health by focusing on the most polluted and highly populated areas first.

Criteria Three – Optimize both the quality and quantity of the potential gain in the volume reusable drain water based upon NOPWASD's limited annual budget allocation by focusing on commissioning WWTP's currently under construction but not operating.

Criteria Four - Maximizing the gain of drain for both intermediate and terminal point reuse by ranking those facilities meeting the first three criteria in descending order of volume or reusable water gained by the commissioning of each NOPWASD WWTP proposed.

3.4 Prioritization Methodology:

Prioritization of wastewater treatment construction activities with the pilot area was based upon a seven-tiered screening methodology.

Tier 1 **– *Drain Network Priority* –** Ranks main drains in descending order of pollutant discharge contribution and thus volume of drain water reuse gained through treatment of M&I wastewater discharges.

Tier 2 – Within the Tier 1 ranking, select all WWTP's under construction are listed and those with design capacity of 10,000 cubic meters per day or larger were selected

Tier 3 – Estimate the effect of treatment that will be realized from the successful operation of each listed WTP using the drain classification index. Assume that full treatment capacity of the treatment facility is utilized, and that the resulting WWTP effluent will meet Law 48 discharge requirements. Based upon the reclassification results add the total water gained for reuse according to the change in classification. For example a change from a C drain to an A drain results in a gross increase in reusable water both during high and low flow conditions whereas a change from a C to a B class results in a gain only during high flow periods. Those WWTP that resulted in a significant change in drain classification where lumped as Tier three selections. Those improvements that did not impart a change in drain class were dropped from the list.

Tier 4 – Tier 3 WWTP improvements were then prioritized in terms their anticipated positive impact on human and environmental health through their effect on drain classification. For example, a change from a C drain to and A drain was given priority over a change from C to B while construction of a WWTP that results in no significant change in drain class was given last priority.

Tier -5 Candidates selected under Tier 4 were prioritized in descending order with regard to the volumetric gain in reusable drain water.

4 RESULTS

4.1 Classification Results:

The first step to managing pollution is to ascertain the type, extent, location, and distribution of pollutant sources. Once this is known, a means or guide to distinguish acceptable from unacceptable (polluted) drain water for reuse is needed. Classification of drains in regard to the water reusability is one means by which to distinguish between drain qualities and to manage drain water harvesting to optimize water quality.

Classification of drains by discrete sections is necessary since drain water is commingled with M&I Wastes at many different locations and because drains are branched often serving large areas through numerous smaller secondary drains and *mesqas.* Further, classification over discrete drain reaches supports the concept of intermediate drain reuse by identifying those areas of the drain with acceptable quality for intermediate reuse as well as water quality “hot spots” where reuse is to be avoided.

Between the months of May and July, 2001, EPADP Engineers with the aid of the Governorate of Dakhalaiya, completed an inventory of all major point source municipal and industrial discharges to the drain system bounded by the pilot project area. Generally, four pollutant sources were revealed by this field assessment, including wastewater discharges from:

- Wastewater treatment plants;
- Wastewater pump stations (lift stations);
- Gravity lines, and;
- Surface run-off.

Annex 1 presents detailed results of this field survey, listing the polluter, the location of the discharge within the catchment’s area, and the approximate volume of each discharge identified.

Based upon the field survey results and interviews with local drainage operators and EPADP engineers, each of the branch drains was assigned a classification index number by applying the adopted flow based classification methodology, using the A, B, and C categorization as a function of their calculated index number. Annex 2 details the resulting drain classification of main drains, secondary, and branch drains including their flow contributions, classification index, and classification. Table 4.1 Provides a summary of the classification of the main drains feeding El Salaam Canal, the fraction of branch drains within the main drainage classified under each category, and their respective flow contributions.

Table 4.1 **Summary of Drain Classification of West Salaam Catchment**

Drain Name	Length of Drain (Kilometers)	Daily Flow (1000 m3/day)	Index Number	Class	% of Flow
Hadous Drainage	**281**	**13480**	**12.6**	**C**	**79%**
Bahr Hadous	66	7901	15.2	C	59%
Bahr Saft	65	3102	10.8	C	23%
Ganabyat Al Nezam	7.4	477	2	A	3.5%
New Ganabyat Al Nezam	11.5	385	10	B	2.9%
Zorfzaki	13.5	122	8.5	B	0.9%
Left Ganabyat Hadous	8.5	434	3.3	A	3.2%
Alebedy	13.3	117	1.8	A	0.9%
Merga	6.8	75	29.3	C	0.6%
Elfrad	4.8	20	0.5	A	0.1%
Abdel Rahman	17.5	197	6.4	B	1.5%
Shalaby	21	73	0.7	A	0.5%
El Genena	17	128	0.1	A	0.9%
Upper Omom El Beheira	29	449	18	C	3.3%
Serw Drainage	**46**	**2317**	**5.0**	**B**	**14%**
Upper Serw	27	650	8	B	28%
Lower Serw	19	1667	3.9	A	72%
Farasqour Drainage	**29.9**	**1166**	**6.1**	**B**	**7%**
Farasqour	11	566	10.4	C	49%
Al Atawy	16	468	2.2	A	40%
Old Basarta	2.9	132	3.1	A	11%

As previously mentioned, The West Salaam Canal Catchment Area is made up of three main drainages; The Hadous, Serw, and Farasqour. Schematic Layouts of each of these three drains indicating the classification results are included as Annex 3.

Bahr Hadous Drain

Bahr Hadous drain is the largest drain feeding El salaam Canal supplying 70% of all drainage to El Salaam. The estimated flow of the drain, based on the calculated discharge out of the lifting pump station, is about 2.095 BCM/year. The current amount of water lifting to El Salaam Canal from Bahr Hadous drain is about 0.308 BCM/year. In the future it is anticipated that as much as 1.3 BCM/year will be harvested from the Bahr Hadous to supply El Salaam Canal. The Bahr Hadous Drain itself is about 66 km long serving a catchment area of about 812,000 feddans. The total length of drain in the Hadous Catchment is 1477 kilometers.

The Bahr Hadous forms the Main Drain of the Hadous Drainage. The total amount of Drainage water common out of the Hadous catchments area is about 7.6 MCM/day divided in to 6.9 MCM/day agriculture drainage water, 0.5 MCM/day sewage water and 0.2 MCM/day industrial water. The Hadous drain is of class (C) with a classification index of 12.6. The total length of branch drains of class (A) is 490 kilometers conveying 8.5% of the total flow of the catchment. The length of branch drains of class (B) is 305 kilometers and the associated flow within this drain fraction is 5.5 %. The length of branch drains of class (C) is 616 kilometers accounting for 86% of the total drain water produced within the drainage area.

Upper and Lower Serw Drains

The Serw Drain is presently distinguished as two drains, The Upper and the Lower Serw. Presently it is intended to draw from the combined outflows of these drains to supply El Salaam canal with 0.4 BCM/ year drain-water.

The total length upper Serw and its branches is about 141 km. and serves an equivalent area of about 50,000 feddans. The length of branch drain of class (A) is 53 km. The length of branch drain of class (B) is 34 km. The length of branch drain of class (C) is 28 km.

The total length of Lower Serw and its branches is about 177 km serving an area of approximately 66,000 feddans. While the composite classification of the Lower Serw Drainage of class (B), the Lower Serw Drain itself is of Class (A) The total length of branch drains of class (A) in the Lower Serw Catchment Area is 132 km. The length of branch drain of Class (B) is 27 km. The length of branch drain of class (C) is only 18 km.

The total amount of Drainage water coming out from the Lower& Upper Serw catchment area is about 2.3 MCM/day divided into 2.2 MCM/day agriculture drainage water and 0.1 MCM/day sewage and industrial wastewater.

Farasqour Drain

The total area served by Farasqour pump station is about 20,000 feddans. Farasqour Drain will supplement El Salaam Canal with 0.3 BCM/year of drainage water if the water from both Bahr Hadous and Serw drains is not sufficient. The remaining drain-water is required to maintain freshwater fisheries in Lake Manzalla. The drain is discharging now to lake Manzalla through Farasqour mixing pump station with capacity of 388 MCM/day. The total length of the Farasqour Drain and its branches is about 64 km. The length of main-drains: Farasqour, El Atawy and Old Basarta Drains is about 11, 16 and 3 Km long respectively. The Farasqour drain is of class (C), El Atawy & Old Basarta are of class (A). The length of branch drains of class (A) is 25 km long. The length of branch drains of class (B) is 5 km long. The length of branch drains of class (C) is 5 km long.

4.2 Prioritization Results:

Utilizing the existing NOPWASD Construction Activities list provided by NOPWASD for this purpose, APRP and EPADP Engineers applied the pre-developed screening and selection criteria to prioritize the on-going WWTP construction activities within the West Salaam Drainage Catchment Area. A final Prioritized list of NOPWASD Activities for each of the drainages located in

the West Salaam Canal Catchment Area through the year 2007 is presented as Annex 4.

5 Discussion of Results

5.1 Discussion of Classification Results:

Classifying drains in terms of water quality in general brings to light several important implications with regard to future drain-water reuse and management of both, in El Salaam Canal, and at the national level. The activities and subsequent findings resulting from Pilot Study #1 Classification of Drains have immediate and far reaching implications in regard to the to existing reuse management scheme and to the course of evolution of drain reuse management in Egypt in the future.

Generally speaking, drain classification represent several potential applications such as:

- An analytical tool to assess the extent and magnitude of the drain-water pollution problem;
- A management tool to optimize drain-water harvesting, mixing, and allocation strategies, and;
- A planning tool to identify the location and extent of required pollution mitigation measures required and predict the effect that mitigation will have on water quality within the drainage network.

Results of the Drain Classification Pilot Study in El Salaam Canal Catchment Area indicate that pollution of drains by municipal and industrial wastewater discharges is significant. From Table 2 we see that by volume approximately 59% of all the water contained within El Salaam Catchment Area or 50% of the drains by length are by the classification methodology too polluted to reuse. Similarly, 12% of the water within the drainage is of marginal reuse value. Water in these drains should only be reused during periods of high agricultural return flows when there is significant dilution. This leaves only 30% or 1.3 MCM/day of high quality drain-water in El Salaam Catchment Area. While downstream mixing effects quickly reduce the quality of class A drains, the fact that 110 km of drain are Class A clearly supports intermediate reuse on these drain reaches.

Most importantly however, are the implications that classification of the drains within the pilot area has on the El Salaam project itself. Under the proposed management plan for El Salaam Canal, 2 BCM / Year of drain-water is to be harvested from the three major drains presently feeding The Canal: The Bahr Hadous, The Serw, and if necessary, by The Farasqour Drain. Classification results from the Drain Classification Pilot Study however, indicate that of the 6.2 BCM/ year passing through the West Salaam Canal Drainage Area only 1.3 BCM/year is high quality (Class A) drain-water. Class A, “high-quality “ drain-water, is found primarily in smaller branch drains high in the catchment area. Instead of allowing this water to mix with polluted drain-water downstream, it could be selectively harvested through sanctioned intermediate reuse.

Approximately 4 BCM of drain-water flows from the West Salaam Canal Catchment Area on an annual basis. Under the present reuse management scheme one half of this drain-water (2 BCM / year) will be harvested to supply El Salaam Canal. One and three tenths BCM will be harvested from Bahr Hadous Drain. The remainder (0.7 BCM) will come from Serw Drain. Drain water not diverted to El Salaam will continue to feed Lake Manzalla unless additional water is required in the future. Under the proposed harvesting strategy, drain-water harvested by El Salaam Canal has a composite index of 10. By classification this water is not suitable for reuse (Class C). After mixing in a 1:1 ratio with fresh water from the Damietta Branch of the River Nile it is predicted that the resulting water will be of Class B (Class Index 5 $< I_C < 7.5$). Following the drain classification definition, Class B water is of adequate quality only during periods of high irrigation return flow. During low flow conditions alternative management schemes will be required to continue delivery of high-quality irrigation water through The Canal. By utilizing the drain classification methodology, it becomes obvious that improvements in the existing drain-water quality within the drain-system feeding El Salaam Canal are necessary in order to meet the year-round demand for high quality irrigation water (Class A) for the North Sinai Horizontal Expansion Project. Further, should future water demands on El Salaam , additional drain-water harvesting will become necessary. If improvements in drain-water quality are not realized, particularly in the Bahr Hadous, the resulting mixed water quality may not be adequate to protect The New lands of North Sinai from surface water pollution.

5.2 Discussion of Prioritization Results:

As previously mentioned, prioritization of WWTP construction activities seeks to achieve two principal goals:

1. To expedite to commissioning of new NOPWASD WWTP's, and;
2. To maximize to positive water quality impact on drains in an effort to facilitate the drainage reuse effort.

6 Conclusions:

6.1 Need for Expanded Centralized Treatment Facilities:

An inventory conducted by EPAD and Governorate of Dakhalaiya researchers and engineers found that the total volume of M&I wastewater discharges to the West Salaam Drainage Area is 328 MCM per year while the available centralized WWTP design capacity is only 69.5 MCM , thus reflecting a present WWTP shortfall of 258.5 MCM / year, or 79%. Construction of additional WWTP's are required to reduce this shortfall. The MWRI looks toward NOPWASD to fill this role by continuing the construction and commissioning of new WWTP's to serve large population centers and their surrounding villages.

6.2 Need for Decentralized Treatment:

While the construction of new centralized WWTP's addresses the waste-streams generated from large population centers, much of the pollution entering drains is generated by the many small rural villages and Ezbas , which are densely distributed throughout the project area. These smaller point sources cannot be effectively addressed by conventional centralized WWTP's due to reduced economies of scale and high collection cost makes centralized treatment of wastes generated by smaller dispersed sources cost prohibitive, particularly in light of NOPWASD's limited annual budget. Decentralized waste treatment systems can be utilized to fill this void in sanitary coverage. Appropriate low cost, low maintenance wastewater treatment technologies such as small bore

collection systems, constructed wetlands, UASB's, and EM technologies exist that could be utilized in smaller dispersed communities where conventional wastewater treatment is costs prohibitive.

6.3 Need for local Management, Staffing and Training:

While NOPWASD is responsible for the construction of WWTP's and their associated collection systems NOPWASD does not presently allocate budget for spare parts and operator training. Therefore quite often newly constructed WWTP's are handed over to the governorates without trained management staff and O&M personnel nor a means for acquiring additional spare parts. Adequate training of WWTP personnel and a budgetary mechanism for insuring that adequate repair and replacement is critical to insure that WWTP's can continue to operate efficiently in the future.

7 POLICY IMPLICATIONS:

7.1 Classification to Refine Drain Reuse Management:

Drain classification provides the tool necessary to refine drain reuse management in two principal ways. First drain classification provides a means by which to assess overall quality, quantity, and location of reusable drain water and it proximately to its intended location of reuse thus allowing reuse planners to better assess cost and benefits associated with future drain water reuse projects. Secondly, drain classification may be used as an indicator to focus treatment efforts and also provides a means by which to estimate the gross effect that a particular WWTP project will have on the condition and amount of reusable drain water gained by completion of the proposed WWTP. Classification of drains should be used to optimize water quality and allocation as well a planning to tool to prioritize WWTP construction activities.

7.2 Move Toward Drain Quality Separation:

Drain classification provides the basis to begin to reuse drain water selectively by identifying water quality "hot spots" where water should not be reused. Selective reuse of drain water is a major step towards segregating the drain system to optimize reuse water quality and avoids the introduction of damaging pollutants into the reuse system. Under a segregated drain system highly reusable water would be harvested for reuse while highly polluted water would be directed to common areas for future treatment and/or disposal.

7.3 Extended Drain Classification Nationally:

Drain classification should be implemented throughout he national drain system. The planning functioned of drain classification both as a predictive as well as a prioritizing tool should be fully utilized in the development of future drain water reuse strategies.

7.4 Continued Collaborative Efforts Between MWRI and NOPWASD

7.5 Implementing Prioritized Wastewater Treatment Infrastructure Construction

Prioritization of WWTP Construction Activities to achieve specific drain water quality targets provides two major benefits.

3. Focuses and streamlines NOPWASD's Construction cost in an equitable and unbiased manner.
4. Maximizes human and environmental benefits gained through NOPWASD's efforts.

7.6 Implications for Intermediate Re-use

An interesting conclusion becomes apparent from the findings of the Drain Classification Pilot Study. The fact that drain-water quality is generally the highest in the upper reaches of the drainage catchment areas declining as drain-water flows through the middle and into the lower drainage areas due to the cumulative effects of waste discharges to the system. Classification results demonstrate that even small, highly polluted branch drains can impart significant negative impacts on downstream water quality thus reducing the final quality of the main drain. This undesirable effect was found to have its greatest effect on drains of marginal quality (Class B) and when a downstream drain is affected by the cumulative impact of several polluted upstream drains. In El Salaam Canal for example, it was found that none of the water in the three drainages is Class A by the time it reaches El Salaam Canal.

While the volume of Class A drain-water is small in comparison to the total volume of The West Salaam Canal drainage Area, however, the length of Class A Drain (110 km) is significant. Within network itself approximately 1.3 BCM of Class A drain-water is available annually along smaller drains high in the watershed. Under existing MWRI policy, the reuse potential of this water is not effectively exploited through the downstream mixing process and its volume offers little dilution potential to the much larger flows present in large main drains. Such an observation brings into question whether mixing of combined drain-water in large main drains is the most efficient and effective means to reuse drain-water. The significance of this degrading effect favors the sanctioning of direct intermediate drain water reuse "high" in the catchment area rather than through mixing low in the drainage. Perhaps intermediate reuse of high-quality (Class A) drain-water is should be incorporated into the overall drainage reuse strategy. In this particular case we compare the two approaches simply in terms of availability of high-quality drain-water for reuse to find approximately 1.3 BCM/ Year of high quality drain-water could be made available for sanctioned intermediate reuse.

Availability is not the only issue in regard to El Salaam Canal. One cannot overlook the principal objective of the project, which is to deliver water to new lands in the Sinai. Intermediate reuse does not fulfill this objective. What is clearly evident though, is that drain classification provides one critical management tool necessary to optimize the most beneficial reuse management schemes regardless of the objectives at hand.

Drain classification can be used as a planning tool to identify the location, extent, and type of pollution mitigation measures required to improve drain-water quality. This application was used in the adjoining Prioritization of Wastewater Treatment Plant Construction Activities (Pilot Study #2). In this application, drain classification is used as a predictive indicator in determining the effect that mitigation will have on water quality within the drainage network. This is a critically important function in terms of ongoing mitigation activities operating under limited budgetary constraints. Using drain classification in this way allows limited resources to be implemented in a manner that will maximize their benefit when and where it is needed most thus offering the most gain for the investment and maximizing the effect that a limited budget can have in attaining the desired outcome.

Annex 1,
Appendix B

Inventory of Wastewater Inputs to Pilot Area

Ministry of Water Resources and Irrigation
US Agency for International Development
Agricultural Policy Reform Program
Environmental Policy and Institutional Strengthening Indefinite Quantity Contract

APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

APPLICATION OF POLICIES AND PROCEDURES FOR IMPROVED URBAN WAStewater Discharge and Reuse

Report No. 46
Appendix C

December 2001

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

Appendix C

Wastewater Irrigation for Urban Green Lands

UWDR Tranche IV Benchmark,
prepared in fulfillment of Pilot Project 3

By Dr. Mamdouh Riad of MALR

APPENDIX C

IRRIGATION OF URBAN GREEN LANDS WITH TREATED MUNICIPAL WASTEWATER

Prepared by
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Undersecretary of Forestation Ministry of Agriculture and Land Reclamation

8 INTRODUCTION

8.1 Background

Egypt, a desert country of more than 65 million people, generates approximately 7.2 BCM of combined municipal and industrial wastewater per year. Presently, the majority of this wastewater is discharged back into the national irrigation system either directly to the Nile River, or indirectly and, most commonly, through the agricultural canal and drain network. Wastewater enters the irrigation network most commonly through agricultural drains intended to remove excess irrigation water. Drain water is in turn reapplied to agricultural crops either directly, though illegally, by farmers in water limited areas, or indirectly through government sanctioned mixing of drain and freshwater. Additionally, in areas of water scarcity, drain water is used to water livestock, bathe, and even clean household utensils. Drain water contaminated with improperly treated and raw wastewater therefore presents serious potential environmental and human health risks to Egypt and to Egyptians.

Separation of wastewater from other surface waters reduces pollution and its associated risks. Separation implies finding a means of exhausting wastewater at the source. But M&I wastewater should not be discarded without considering its beneficial uses in a water limited desert country such as Egypt.

In terms of availability, domestic and municipal wastewater is a viable water resource. It is dependable since its very presence is a direct result of human activity. Presently, M&I wastewater comprises 13% of the country's annual freshwater allotment from the Nile, a sizable volume. Utilizing wastewater in an exhaustive manner rather than discharging it to drains and other surface waters serves to reduce water pollution , but should also provide a beneficial service.

Treated wastewater is commonly used in many parts of the world for agriculture. Wastewater is excellent for agricultural use because it is generally low in salinity and provides additional nutritive value. However, unrestricted use of improperly treated wastewater in agriculture involves potential risks to farmers, field workers, and to consumers of food and fiber crops. Unrestricted reuse of wastewater for food and fiber crops is not presently supported by the GOE nor advocated by any of its ministries. On the other hand, the Ministry of Agriculture (Department of Afforestation) actively advocates the restricted use of treated wastewater for cultivation of selected non-food crops such as timber trees. Restricted use implies that control measures are employed to minimize potential health risks and associated negative impacts.

Cultivation of timber trees in the desert, utilizing treated wastewater, is just one example of a beneficial use for wastewater. Timber forest irrigation with wastewater has been successfully practiced in Egypt for more than five years. Nationally, there are nine officially recognized experimental wastewater tree farms, incorporating more than 4,000 feddans (1,600 hectares) of forest. Using sandy desert soils and wastewater, receiving at least advanced primary treatment, seven commercially valuable tree species are being grown including African Mahogany, Eucalyptus, Mulberry, Pine, Poplar, and Acacia. Results have shown that trees cultivated using wastewater appear to grow faster and more vigorously than similar trees irrigated with freshwater alone.

While the use of wastewater in deserts is a viable disposal option for much of the Nile Valley, as the desert is reasonably close, it is not realistic in the Nile Delta where most settlements are far from the desert. Desert forests become impractical in many such communities due to added costs associated with transporting the wastewater over any great distance. An alternative use for treated wastewater in these areas is the irrigation of much-needed urban green areas. In theory, treated wastewater could be utilized to provide water to roadway medians and shoulders to cultivate urban green lands while simultaneously exhausting wastewater.

Policy Reform #10 recommended the use of treated wastewater for the irrigation of urban green lands as one possible means to utilize wastewater beneficially.

Under Tranche IV, Phase II of the UWDR benchmark, The Afforestation Department of MALR, in cooperation with MWRI and Dakhalaiya Governorate, conducted a pilot program applying Policy Reform #10 on a limited basis by using wastewater effluent to grow ornamental trees along a selected highway in Mansoura Governorate.

8.2 Benchmark Verification Indicator

Verification of the successful completion of Pilot Project #3 was the establishment of an urban green lands area irrigated with treated wastewater and a final report documenting the activities, results, recommendations and implications.

This appendix and the attached Environmental Impact Assessment (Annex 1) are intended to document the activities, results and recommendations of Pilot Project #3, Irrigation of Urban Green Lands Utilizing Treated Wastewater in fulfillment of the benchmark activity.

8.3 Pilot Project Participants

The Drain Classification Pilot Project required the collaborative participation of:

- The Ministry of Water Resources and Irrigation (MWRI);
- The Ministry of Agriculture and Land Reclamation (MALR), and;
- The Governorate of Dakhalaiya.

8.4 Pilot Project Activities

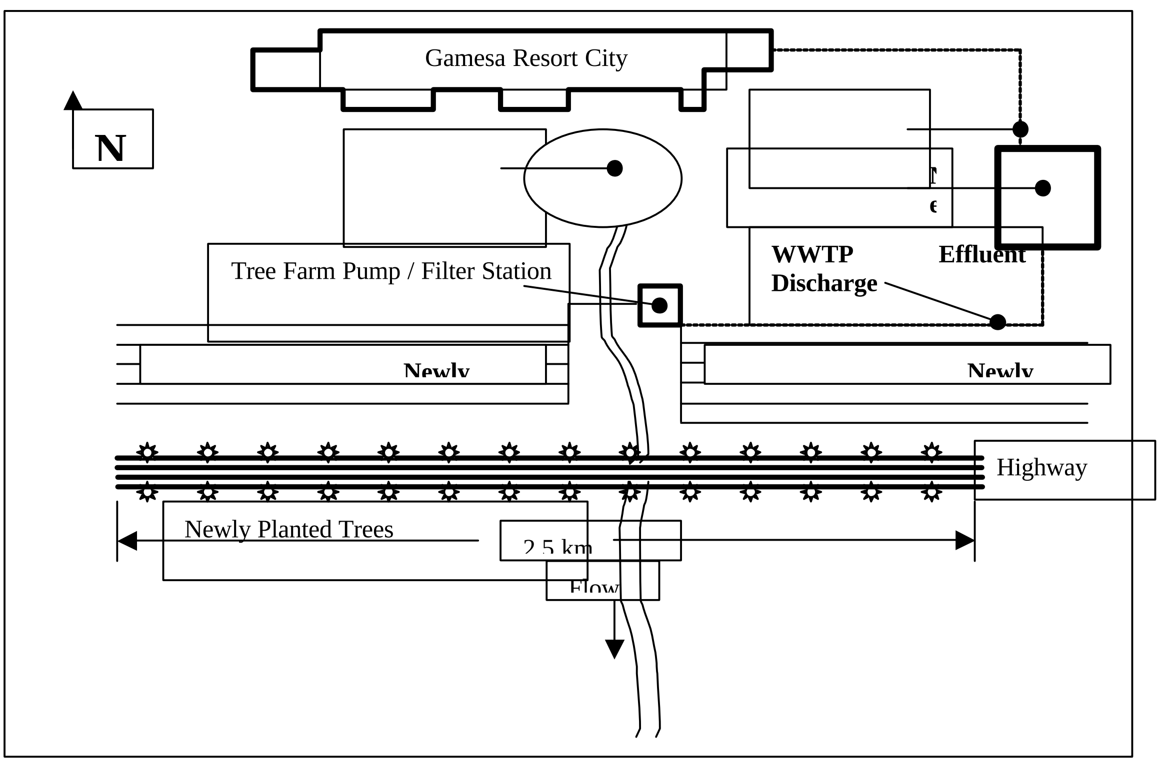
Activities within the scope of the Irrigation of Urban Green Lands with Treated Wastewater Pilot Project included:

- Close collaboration among MWRI, MALR, and Governorate of Dakhalaiya;
- Selection and agreement on an appropriate location for the pilot project;
- Design and construction of necessary irrigation infrastructure;
- Planting and irrigation of roadside ornamental trees with treated wastewater, and;
- **Compilation of a final report summarizing the pilot project activities, results, and policy implications in the form of a final report presented to the EPIQ Group before October 2001.**

8.5 Pilot Project Study Area

The Pilot Site selected for Project # 3 is five-kilometer stretch of a newly refurbished highway located near-by to Gamesa Resort City located adjacent to the new Gamesa Wastewater Treatment Facility and tree farm. Figure 1 provides a schematic layout of the demonstration site.

Figure 1 General Layout of Gamesa Green Land wastewater Irrigation Pilot Project Site (*not to scale*)



8.6 Pilot Project Results

Inter-ministerial Collaboration

Pilot Project #3 was successfully completed through the diligent collaborative efforts of the MWRI, MALR, and the Governorate of Dakhalaiya. Cooperation and sharing of project tasks was critical to completing the pilot project successfully and on time. Lastly, a final report was composed through the collaborative efforts of the MALR, and the EPIQ working group.

Pilot Area Selection

Selection of the pilot area was carried out through meetings, discussions, and site visits among EPIQ, MALR and Governorate of Dakhalaiya representatives. Initially, a pilot site near the recently commissioned Mansoura Wastewater Treatment Facility was selected. After several site visits however, it was realized that the Mansoura site was not suitable for wastewater irrigation due to several limiting factors. Factors affecting the decision to select a second site were:

- Adequate infiltration area near to trees was not available, and;
- Soil structure did not permit continual irrigation of wastewater.

Selection of a more appropriate pilot study area for the application of treated wastewater as an irrigation source for urban green lands outside of Gamesa Resort City was preferred, as a large road shoulder and loosely compacted sandy soil made this site an ideal location to establish an urban green area to be irrigated with treated wastewater.

Irrigation Infrastructure

Wastewater is delivered under pressure via a pumping facility constructed for this purpose. The irrigation delivery system is of the drip emitter type and it is functioning well, with adequate pressure and well-distributed flow. Figure 1 depicts the treated wastewater pump and filter set-up used to deliver wastewater to the newly planted green area.

Figure 2 Irrigation Infrastructure for Urban Green-lands Demonstration Project

Planting and Irrigation of Roadside Ornamental Trees
Ornamental trees were planted with an average height of 2-3 meters. They are planted on 10-meter centers on both sides of the highway in sandy desert soils. Treated wastewater will be supplied by a new treatment facility adjacent to the pilot study area. Treated effluent is supplied to each tree by a non-clogging drip emitter. Water is applied continuously to each tree at an approximate rate of 30-40 liters/tree/day. Figure 2 is a photograph of the completed site.

Figure 3 Newly Planted Urban Green Land, Irrigated with Treated Wastewater

Commissioning Ceremony
Approximately 30 participants traveled to the site of the newly established Urban Green-lands Wastewater Forestation Project to take part in the opening ceremony of the facility in Mid August 2001. The Governor of Dakhalaiya and representative Governorate officials, engineers and scientists, as well as MALR, EPIQ, MWRI Undersecretary to
Dakhalaiya attended the ceremony, Figure 3. The event received local press coverage as well as exclusive interviews with the Governor and MALR project representative Dr. M. Riad by the Good Morning Cairo TV News Team (Figure 4.) This ceremony is considered significant to the Agricultural Policy Reform Program as it symbolizes the completion of the Tranche IV, C.2 Phase II Benchmark “Green Land Wastewater Irrigation” Pilot Study #3.

Figure 4 Attendees of Commissioning Ceremony for Urban Green-land Wastewater Irrigation Demonstration Project

Figure 5 Interviews with the Governor and MALR project representative Dr. M. Riad with the Good Morning Cairo TV News Team

8.7 Conclusions

Pilot project #3, Irrigation of Urban Green-lands with Treated Wastewater, successfully demonstrated that the use of wastewater for irrigation of urban green lands is a feasible practice provided specific site conditions can be met and maintained. Areas of concern identified in the Environmental Impact Assessment prepared for this pilot project include:

- Public exposure issues;
- Space considerations;
- Groundwater considerations;
- Adequate soil type, and;
- Cost of distribution and application of treated wastewater.

Public Exposure Issues

Wastewater containing pathogens, viruses, and toxic substances such as heavy metals and volatile organic compounds impose potential human and environmental health risks. The application of wastewater to urban green lands, where the potential for human contact is high, should be restricted or wastewater should be applied in such a manner that the potential for exposure is minimized.

Available Space

Application of wastewater to urban green-lands requires adequate area not only for the planting of trees themselves, but also for the installation of irrigation delivery infrastructure (pipes and emitters), as well as an additional buffer area to absorb any wastewater not utilized immediately by the target vegetation (ie excess runoff).

Groundwater

Contamination of groundwater supplies by wastewater used to irrigate urban green lands must be taken into consideration. Wastewater irrigation should not be conducted where groundwater is used as a potable water supply.

Adequate Soils Type

Application of wastewater to urban green lands requires a loose sandy or similar soil structure capable of absorbing continual application of wastewater without surface pooling.

Distribution and Application of Treated Wastewater

Costs of irrigation and distribution infrastructure must be considered feasible and appropriate for each application of this practice. Generally, if a piped system is to be used, it should be reasonably close to the wastewater treatment facility to minimize piping and pumping costs. The economics of alternate methods of delivery, such as tank truck, should be investigated.

8.8 Policy Implications

Properly treated wastewater represents a significant national water resource especially in water-limited, hyper-arid countries. Developing beneficial uses for treated wastewater is a challenging new aspect of water resource management in Egypt. Irrigation of tree crops has demonstrated measurable success in earlier MALR Desert Forestation Projects in nine project areas throughout Egypt. Pilot project #3, Irrigating Urban Green Lands with Treated Wastewater, demonstrated that irrigation of urban green lands, such as ornamental roadside trees, is another effective means of utilizing treated effluent. As such, there should be encouragement for irrigation of urban green lands to expand green areas in and around population centers, particularly in the Delta where access to desert lands for timber tree farming is limited, provided the aforementioned site conditions can be successfully met.

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Report No. 46
Appendix D

December 2001

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

Appendix D

Health Awareness and Wastewater Quality Monitoring of El Salaam Canal

UWDR Tranche IV Benchmark, prepared in fulfillment of Pilot Project 4

By Dr. Sehem Mohamed Hussein of MOHP

APPENDIX D

HEALTH AWARENESS AND WASTEWATER QUALITY MONITORING OF EL SALAAM CANAL

Prepared by
Dr. Sehem Mohamed Hussein of MOHP

9 INTRODUCTION

9.1 Background

The primary threats of wastewater irrigation to human health are pathogenic organisms including bacteria, viruses, protozoa, and helminthes. Several laws have been adopted by the Government of Egypt to control levels of these potentially harmful pathogens discharged to surface waters.

Specifically, GOE Ministerial Decree 44/2000 works together with Law 48/1982, establishing water quality discharge standards for wastewater. Decree 44/2000 sets the standard of 5000/100ml and 1000/100ml coliform bacteria as a secondary treatment discharge standard as well as a nematode standard of 5 and 1 egg/liter for primary and secondary treatment discharge standards respectively. Drain water most often exceeds these standards significantly.

Reuse of agricultural drain water raises concerns in regard to human and environmental health in relation to water quality since:

- Drains are the recipients all types of wastes generated by domestic, commercial, and industrial activities, and;
- Contact (exposure) with drain water is high, particularly where adequate fresh water is limited, use of freshwater is curtailed by ineffective sanitary coverage, or when drain water is reapplied to croplands for food and fiber production.

Drains commonly receive solid and liquid wastes generated from domestic, municipal, commercial, industrial, and agricultural activities. Waste discharged to drains has a significant degrading effect on drain water quality. Principal pollutants of concern in drains include:

- **Inorganic salts and nutrients;**
- **Human pathogens and viruses;**
- **Heavy metals, toxic chemicals, hazardous waste;**
- **Organic and inorganic silt and suspended material, and;**
- **Solid refuse.**

The spread of surface water pollution and a high degree of exposure for select population groups through contact with drain water are two issues of concern. Irrigation managers and engineers, farm laborers, farmers, their families, and the consumer public are at risk as a result of contact with polluted drain water. Awareness of the health effects associated with wastewater and proper management practices are therefore necessary to educate and protect target populations.

9.2 Objectives

The Ministry of Health and Population is the lead agency responsible for protecting public health and monitoring wastewater quality of treatment facilities. It is therefore the recommendation of the UWDR wastewater task group that the MOHP, in cooperation with MWRI and NOPWASD, strengthen public awareness education on the human health risks of wastewater irrigation. All cooperating ministries should establish a better understanding of the various potential mitigating measures and their application under Egyptian conditions.

MOHP should increase its scientific research to examine human health risks from wastewater irrigation in the Egypt. In response to this recommendation, the Ministry of Health and Population (MOHP) applied UWDR Policy Reform #4 by:

- **First, leading two workshops on health concerns surrounding the risks, effects of exposure to contaminated drainage and proper precautions and management practices when working with drain water irrigation. These workshops targeted wastewater treatment personnel, health workers, and farm groups. The workshops addressed critical health issues and prevention measures for irrigation and drain management officials, and for farmers and crop handlers.**

- **Second, applying Ministerial Decree No. 44/2000, establishing water quality monitoring points in El Salaam Canal Catchment Area to compare critical water quality parameters against national and internationally accepted standards..**

9.3 Participants

Participants in Pilot Project #4 included:

- The Ministry of Health and Population (MOHP);
- Ministry of Water Resources and Irrigation (MWRI), and;
- The Dakhalaiya Governorate Authority.

9.4 Activities

Activities under Pilot Project #4 included:

- Organizing and presenting a health awareness workshop to management officials;
- Organizing and presenting a health awareness workshop to farmers;
- Identifying water sampling points in El Salaam Canal, and;
- Conducting water quality analysis of one sample round from the selected points in El Salaam Canal.

9.5 Results

9.5.4 Health Management Awareness Workshop I (Management Officials)

This health awareness workshop was held in the Dakhalaiya Governorate on 16-17 May, 2001, and was presented by Dr. Sehem Mohamed Hussein – General Director of the Environmental Health Department. A detailed synopsis of the workshop content and a list of attendees are included in Annex 1. The workshop training staff included:

- Dr. Sehem Mohamed Hussein – General Director of the MOHP;
- Chemist Ragaa Godo Youseff – Director of Wastewater Department MOHP;
- Dr. Mohamed Sayed El Gowaly. Professor of Community and Environmental Health Ain Shams University, Egypt
- Dr. Zhongping Zhu – Senior Water Resources Engineer – EPIQ

- Dr. Ibrahim Elassiouti – Senior Water Resource Management Specialist – EPIQ

Participants in the workshop included managers of water, wastewater, and drainage resources:

- Engineers and managers from DEGAWS (Dakhalaiya Economic General Authority for Water and Sanitation);
- Treatment Station Operators from Mansoura, Damass, Samaha, Bermban, El Gediade, Meet Mazah, Salamoun, and Meet Damsees
- Representatives from the Giza & Dakhalaiya Drainage Authority;
- Engineers from the Dakhalaiya Irrigation Department;
- Managers from the Dakhalaiya Environmental Health Department;
- Technicians from the Dakhalaiya Ministry of Health and Population testing Laboratories;
- Representatives from the Ismailia Executive Authority for North Sinai Development.

Issues presented and discussed during the health awareness workshop for managers included:

Dr. Sehem Mohamed Hussein:

- An overview of water resources and water management in Egypt;
- A brief history of wastewater treatment and reuse in Egypt and other countries;
- Strategies and priorities of environmental health management in Egypt;
- Situation Analysis of water and sanitation services in Egypt;
- Reuse of treated wastewater in irrigation and potential health and environmental hazards;
- Protective measures for: farmers, crop handlers, consumers, persons living near wastewater irrigated areas
- Egyptian regulations in the area of wastewater reuse
- Law 48/1982 and Law 93/1962
- Ministry of Housing Decree 44/2000
- WHO guidelines and the water quality standard
- The role of regulation in the protection of health and the environment

Chemist Ragaa Goda Youssef

- The role of wastewater treatment processes in eliminating pollutants;
- Physical and chemical properties of domestic wastewater and important water quality parameters: BOD, COD, TDS
- Biological pollutants: pathogenic bacteria, viruses, protozoa, and helminthes
- **Effective pathogen dose and survival rates in soil and water**
- Methods of wastewater treatment: primary, secondary
- Effects of disinfection on pathogen content of treated wastewater
- Advanced methods of wastewater treatment
- The effects of domestic wastewater discharges on fresh water quality in the Nile and its canals

- Water quality of agricultural drainage in Egypt
- Organic pollutants, inorganic pollutants
- Natural treatment
- The environmental impact of wastewater discharge on water bodies in Egypt

Mohamed Sayed El-Gowaly

- Health impacts associated with wastewater irrigation
- Occupation health hazards to workers in wastewater treatment plants
- Health hazards to people in the areas surrounding wastewater treatment and disposal
- Symptoms and signs of disease and methods of personal protection
- Protective measures for the community with regard to wastewater related diseases
- Exposure to chemical pollutants and toxic gases in wastewater treatment plants
- Occupational protection and personal protection equipment
- Vaccination and its effect on protection
- Egyptian laws of occupational health

9.5.5 Health Management Awareness Workshop II (Farmers and Crop Handlers)

This health awareness workshop was held in the Dakhalaiya Governorate on July 26, 2001 and was presented by MOHP representative, Dr Sehem Mohamed Hussein – General Director of the Environmental Health Department. A detailed synopsis of the workshop content and a list of attendees are included in Annex 1. The workshop training staff included:

- Dr. Sehem Mohamed Hussein – General Director of the MOHP ;
- Chemist Raga Godo Youseff – Director of Wastewater Department MOHP;
- Dr. Mohamed Sayed El Gowaly. Professor of Community and Environmental Health Ain Shams University, Egypt
- Dr. Zhongping Zhu – Senior Water Resources Engineer – EPIQ
- Dr. Ibrahim Elassiouti – Senior Water Resource Management Specialist – EPIQ

Participants in the workshop included managers of water, wastewater, and drainage resources:

- Farmers and youth graduates from the El Salaam Canal Project Sahl El Tina
- Agricultural extension workers, Port Said Governorate, and;
- Workers from the Environmental Health Department of the North Sinai Health Directorate.

Issues presented and discussed during the health awareness workshop for managers by trainers included:

Dr. Sehem Mohamed Hussein:

- Situation analysis of water and sanitation services in Egypt;

- Reuse of treated wastewater in irrigation and potential health and environmental hazards;
- Protective measures for: farmers, crop handlers, consumers, persons living near wastewater irrigated areas
- Practices to protect health and environment in regard to wastewater and potential occupational risks
- The role of regulation in the protection of health and the environment

Chemist Ragaa Goda Youssef

- Introduction to the water resources of Egypt and the need for wastewater reuse
- History of wastewater reuse in Egypt and other countries
- Environmental health strategies in Egypt and their priorities
- Physical and chemical properties of wastewater and important water quality indicators: BOD, COD, TDS
- Biological pollutants: pathogenic bacteria, viruses, protozoa, and helminthes
- The infective dose of pathogens and its survival in soil and water
- Group discussion about the problems facing the new communities in regard to water and wastewater-born disease and protective measures for the family and community.

9.6 Water Quality Monitoring in West Salaam Canal Pilot Project Area

Monitoring of water quality at strategic points within the drain and irrigation system provides the informational basis necessary to manage the quality of reused drainage allocated for irrigation. The Ministry of Health and Population (MOHP) is the lead agency responsible for monitoring wastewater quality. APRP Tranche IV Policy reform #5 recommended that the MOHP take a more active role in fulfilling this important role and expanding its monitoring activities in drains. In response to this recommendation, the MOHP initiated water quality monitoring of the West Salaam Canal Drainage Reuse Project under Phase I of the benchmark and conducted additional sampling and testing during Phase II.

MOHP water quality monitoring technicians and engineers identified eight sampling points along El Salaam Canal critical to overall water quality management. Sampling points selected were in similar location as previous sampling to facilitate historical comparison of the resulting data. Sampling locations included the two major mixing points: the intersection of the Serw Drain and El Salaam, and at the confluence of the Bahr Hadous. Sampling locations were also selected before the Grand Siphon and seven kilometers after the Grand Siphon. During the summer months of June and July 2001 the MOHP collected and analyzed 11 drain-water samples from eight pre-selected sampling points in El Salaam Canal. Sampling points were located:

- At the Mansoura wastewater treatment facility outfall;
- At the beginning of El Salaam Canal;
- After Farasqour mixing point;
- After the Serw mixing point;
- After the Hadous mixing point;
- Before the Grand Siphon;

- Directly after the Grand Siphon, and;
- Seven kilometers after the Grand Siphon

Samples were analyzed for physical, chemical, and biological water quality parameters. Analysis conducted included:

- Total, fecal, and streptococcal coliform bacteria;
- Salmonella and viral cholera;
- Microscopic analysis including worm (Helminthes), protozoa, and algae;
- Physical analysis including temperature, hydrogen ion concentration (pH), conductivity, dissolved solids, suspended solids, dissolved oxygen, and chemical and biological oxygen demand (COD/BOD).

9.7 Results of Water Quality Analysis

Results of water quality analysis are included as Annex 2. These testing results provide a typical “snap shot” of the existing water quality of El Salaam Canal. Water quality analysis of samples collected by the MOHP during the months of June and July 2001 reveals that drains discharging to El Salaam Canal show a pronounced negative water quality impact. Analysis of Mansoura WWTP effluent identifies at least one major contributor to poor water quality. Comparisons between similar analysis conducted on samples collected from the effluent outfall of Mansoura WWTP approximately one year earlier show that while the WWTP was providing effective treating wastewater in the year 2000, results from sampling in the year 2001 indicate that the plant is no longer meeting applicable discharge regulations. Fecal coliform counts exceeded upper limits set by both the MOHP Law 44/ 2000 and 1989 WHO standards. Helminthes counts greatly exceeded all pertinent standards. These results point to the need for continued monitoring and enforcement of discharge standards at wastewater treatment plants. Action must be taken to insure that WWTPs continued to meet legal discharge standards.

In general, while the poor water quality is certainly measurable, presently pollution is assimilated over its distance of travel to the Sinai. By the time drainage reaches the Grand Siphon, it is of acceptable quality in terms of human health indicators for irrigation. Bacteriological and microbial pathogen levels meet Egyptian and WHO standards by the time drainage reached the Grand Siphon. In fact, helminthes are not detected after the siphon at all. This is an interesting observation since samples taken from beginning of the Canal were found to contain significant helminthes eggs (Ascaris 30 / liter).

9.8 Recommendations

Public awareness and education play a key role in developing proper management practices and protection measures necessary to minimize inherent risks associated with wastewater treatment and reuse. It is for these reasons that it is recommended that public awareness and education efforts propagating the best management practices and protective measures for health be continued and expanded. The MOHP should take the lead role in this endeavor but should continue to involve the MWRI and EEAA in developing and administering a national public awareness campaign addressing water-reuse and health-related issues.

Continual water quality monitoring of wastewater discharges and drain water quality are necessary to insure compliance with Law 48 discharge standards, to enforce penalties for non-compliance, and to implement proper drain water reuse management planning. The MOHP should therefore:

- Bolster its efforts in wastewater treatment plant monitoring in step with the expansion of wastewater treatment plant commissioning activities;
- Expand its monitoring responsibilities to include drains critical to drainage reuse, and;
- Continue to work closely with MWRI, NOPWASD, and EEAA to insure enforcement and compliance with pertinent Egyptian environmental laws.

Ministry of Water Resources and Irrigation
US Agency for International Development
Agricultural Policy Reform Program
Environmental Policy and Institutional Strengthening Indefinite Quantity Contract

APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

APPLICATION OF POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 46
Appendix E

December 2001

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

Appendix E

An Industrial Wastewater Management Action Plan for El Salaam Canal

UWDR Tranche IV Benchmark, prepared in fulfillment of Pilot Project 5

By Dr. Samia Gala Saad of EEAA

APPENDIX E

INDUSTRIAL WASTEWATER POLLUTION IMPACTING EL SALAAM CANAL

Prepared by
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1 INTRODUCTION

1.1 Background

El Salaam Canal Project is perhaps one of the more significant and controversial irrigation projects currently underway in the Eastern Nile Delta. El Salaam Canal is designed to serve as the main source of irrigation water to the newly developed areas of The North Sinai Peninsula. Under the proposed management scheme, approximately 4 BCM/Year will be delivered by El Salaam Canal. Water supplied by this important new waterway will be composed of one part drain water harvested from The Bahr Hadous (1.3 BCM/yr.) Serw (0.7 BCM/yr.), and if necessary, The Farasqour Drains, and one part fresh water diverted form the Damietta Branch (2 BCM/yr) of the River Nile. Water conveyed by El Salaam will facilitate the cultivation of 200,000 feddan of desert land to the west of the Suez Canal and 440,000 feddan on the Sinai Peninsula itself.

1.2 Problem Statement:

As the Sinai is considered a "virgin" land, no significant surface water pollution currently exists therefore, maintaining acceptable water quality is as vital as providing consistent quantity. Not only to insure maximum crop production and economic return but also to maintain the Sinai's pristine natural setting and subsequent low level of surface water pollution; and to insure the high quality of agriculture products to be accepted for export. Maintaining the current low incidence rates of many human and bovine parasitic and water born diseases is a national goal to be supported by securing the best-achieved water quality conveyance to Sinai. Presently however, untreated municipal and industrial wastes discharged to the drain networks supplying El Salaam Canal are degrading the drain water quality. Conveyance of industrial and municipal pollutants from the Nile Valley Delta to Sinai could have acute and chronic negative impact on the environmentally sensitive Sinai.

1.3 Objective Statement:

Under Phase I of the ongoing Agricultural Policy Reform Program (APRP) a policy reform recommending an examination of current management issues associated with industrial wastes discharged to drains was approved. Based upon this recommendation, a pilot study conducted in a predetermined area was proposed to demonstrate how such an investigation might be carried forward to the national level.

2 PILOT STUDY

The Egyptian Environmental Affairs Agency (EEAA), in cooperation with MWRI and Dakhalaiya Governorate, developed an action plan and pilot study to address industrial waste discharge along two selected main drains in

Dakhalaiya Governorate. The pilot study was designed to test the recommended policies and procedures resulting from The Program's Phase I. Completion of this pilot study resulted in development of a preliminary action plan which, was approved by the Governorate of Dakhalaiya as well as local industry representatives

The scope of work developed for this study consists of:

1. **Selecting a pilot study area consisting of a predefined section of the main two drains namely Bahr Hadous and El Serw and it tributaries within the Dakhalaiya Governorate;**
2. **Conducting a survey of the Study Area identifying, categorizing, and quantifying industrial sources discharging pollutants to the drain system in question;**
3. **Drafting and action plan to better manage industrial waste inputs;**
4. **Negotiating the draft action plan with governorate authorities and local industries to gain acceptance and approval, and;**
5. **Summarizing the results of the Pilot Project in the form of a final report.**

Specific objectives of the Industrial Wastes Management Feasibility Pilot Study were to:

- **Test and refine the recommended Phase I policies and procedures concerning industrial waste discharges to drains and canals, and;**
- **Continue to expand inter-agency cooperation established during this First Phase.**

2.1 Pilot Area

Selection of the pilot area for The Industrial Waste Management Feasibility Study was based upon the following criteria:

- **The selected pilot area must reside within the Nile Delta Region;**
- **It must include a definable section of main drain;**
- **This drain must be part of the drain water reuse scheme, and;**
- **Must receive identifiable and quantifiable industrial waste inputs.**

After extensive consultation with the Governorate of Dakhalaiya, and several field trips to potential project locations, a section of El Salaam Canal and its tributaries were selected as the study area for this pilot project. The El Salaam Canal was selected since it fit all the previously mentioned selection criteria and forms a critical component of the North Sinai Horizontal Expansion Program.

El Salaam canal is an excellent example of large-scale government sanctioned drain water reuse and the water quality problems associated with such activities in The Nile Delta Region.

This canal collects drain water from four major drains in the east delta, and delivers it to newly established agricultural areas in the North Sinai Peninsula. El- Salaam Canal is the primary source of fresh water to newly reclaimed virgin desert areas of North Sinai; therefore the quality of water supplied by this canal is as vital as its quantity. Presently, pollutants originating from domestic, agricultural, and industrial activities are degrading the water quality of the El Salaam Canal. Categorically speaking, wastes reaching the agriculture drains include both domestic and industrial liquid wastewater as well as leachate from domestic, agricultural, and industrial refuse liberally discarded on the banks of both drains and canals. Conveyance of pollutants emanating from unmanaged waste discharges are transported from the Delta to Sinai and imposing adverse environmental health risks potentially causing acute and chronic health problems as well as long-term negative impacts on agriculture land, live stock and the environment ecosystem at large.

Organic, inorganic and biological pollutants enter the drain water pumped to El-Salaam Canal through four main feeder drains. Major drains supplying El

Salaam include The Mansoura, Taweela, El-Serw , and Bahr Hadous Drains. El Mansoura Drain and El Taweela Drain receive their water from several sub drains where combined domestic and industrial wastes from small and micro-scale industries are discharged. El-Serw and Bahr Hadous drains receive discharge from predominately large industries.

2.2 Pollutant Survey

To gain a better understanding of the magnitude of the deteriorating impacts created by industrial pollutants entering drains within the project area, a comprehensive assessment of the associated polluting sources was conducted.

To realize this task The Dakhalaiya Governorate Environment Department was contracted to collect data regarding the different micro, small, medium and large-scale industrial pollutant sources. Data collected through this survey included the type of industry, type of waste, an estimate of the associated annual waste discharge and its respective discharge point within the project area. Data concerning the different industries was distinguished by:

- **Its geographic proximity to the drains feeding the El-Salaam, and;**
- **By the size of the industry.**

2.3 Survey Results

Tables 1 through Table 11 provide the results of the Dakhalaiya Governorate Environmental Department survey. Table 1 summarizes large industries discharging to El-Mansoura and El-Taweela drains. Table 2 through 11 provide the summary of medium and small-scale industries discharging their wastes in passing by agriculture drains within and across Mansoura, Meet Ghamr, el-Essenbellawane, Bani Ebeid, Temay El Amadid, Meniat El Nasr, Aga, El-Manzala, el-Aziza,El Houta, new Alexandria, Frosat, el Bousrat, El Nasiama, and Meet Salsile urban and surrounding rural areas.

Table 12 provides a summary of pollutants discharged by the different industrial activities in those areas. Table 13 provides an overall summary of pollutants by category.

Table 1 **The Large Scale Industries Discharging to Drains' Water Reaching El Salaam Canal in Dakhalaiya Governorate**

Industrial Sources	Volume of Discharge	Main pollutants	Legal Discharge Compliance Actions
Industries Discharging to El-Mansoura Drain			
El Dakhalaiya Textiles	**1000**	**Organic dyes, salts, phosphates, heavy metals, cotton fibers Petroleum oils and grease**	**The company did not comply with the law, all the studies are done, pending financial approval for implementation**
Mansoura Resins and Chemicals Company	**500**	**Organic matters, phenolic and urea compounds**	**Currently the company is in the process of establishing a wastewater treatment facility to bring its effluent complying with the Law 48**
Misr for Oil and Soap	**1500**	**Edible oils floating and emulsified, alkaline sodium hydroxide, Organic and inorganic Dissolved Solids**	**The company has a wastewater treatment plant and they are complying with the Law 48.**
Industries Discharging to El Taweela Drain			
El Delta For Fertilizers and Chemical Industries	**3000**	**cooling water Ammonia, Urea, dissolved inorganic solids,**	**The company has installed a stripping unit for ammonia and the ammonia loads are reduced from 3970 tons/year to near zero The company is currently installing a process modification for complete urea and ammonia recovery.**
El Nasr for Bottling (Coca Cola Company)	**900**	**Dissolved biodegradable organics, dissolved salts**	**The company is currently installing wastewater system modification and final treatment for the segregated effluents**
Talkha Power Station	**150,000**	**cooling water petroleum products,**	**The station has a treatment plant for oil and grease**

Table 2 **Small Scale Industrial Activities In Mansoura Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Discharged Liquid Wastes characteristics	Estimated loads/ year
Metals forming and lathing	**42**	**Lathing oils with cooling water, fuel oils, suspended heavy metal particles**	**4 tons of emulsified oils**
Aluminum Casting	**30**	**Aluminum fine scrap**	**3.0 tons of solid aluminum**
Dairy Plants	**26**	**Suspended organic solids, dissolved organics in the form of milk, whey, and milk sugars**	**26 tons of BOD, 2 tons of milk fats and 2 tons of milk whey Equivalent to 3 tons of suspended organic solids**
Melamine dishes and plastic utensils manufacturing plants	**12**	**Petroleum oils as lost fuel, organic lubricants**	**One ton of petroleum products**
Tile Manufacturing Plants	**19**	**Suspended solids in the form of clays, fuel oils drippings**	**10 tons of clays, one tone of petroleum products / day**
Car body shops and metal forming workshops	**331**	**Petroleum products, residues of Paints**	**3.3 tons of mixed petroleum and paint products with some pigments containi**

			ng, lead, chromium, nickel as a source of color
Pastry, pasta and ice cream small scale plants (3-10 workers/shop)	**13**	**Dissolved organics, suspended organic solids, edible fats and oils**	**13 tons of BOD, 3 tons of biodegradable oils and floating solids**
Carpenter shops	**48**	**Paints, adhesives**	**20 tons of suspended solids (non-biodegradable)**
Seed millings and de-hulling	**38**	**Suspended organic starches**	**3.8 tons of suspended starches**
Metal plating	**13**	**Cyanides, heavy metals**	**0.02 tons of highly toxic matter**
Tricot and knitting workshops	**161**	**No liquid wastes only solid wastes dumped to municipal wastes**	**None**
Canned foods	**1**	**High dissolved organic wastes**	**2 tons of dissolved BOD**
Plastic forming	**20**	**Oils and lubricants**	**2 tons of petroleum non-biodegradable oils**
Tobacco reforming with molasses	**2**	**Sugars from washing preparation tanks**	**0.2 tons of BOD**
Soap manufacturing	**3**	**Emulsified oils and caustic soda**	**3 tons of BOD**
Textile factories	**6**	**Dyes and residues of petroleum oils, dissolved**	**2 tons of dissolved organics**

		solids	
Manufacturing Carton Boxes	**3**	**Dissolved starches**	**0.1 tons of soluble BOD/ day**
Ready made garments	**4**	**Solid wastes dumped on canal and drains sides**	**0.4 ton of leachates from residues dumped on drains sides**
Lubricating oils stations	**4**	**Non biodegradable oils and lubricants**	**1 ton of non-biodegradable oils**
Battery recharging	**7**	**Highly concentrated sulfuric acid, lead plaques, plastic battery bodies**	**1.0 ton of highly contaminated acids with lead, 0.5 ton of battery lead plates, 0.5 plastic battery containers.**

Table 3 **Small Scale Industrial Activities In Meet Ghamr Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Wastes Characteristics	Estimated Load Tons /year
Aluminum recycling and forming	**16**	**Suspended heavy metal particles**	**4 tons of aluminum solid residues piled on the drains' banks**
Melamine dishes and plastic utensils manufacturing plants	**26**	**Petroleum oils as lost fuel, organic lubricants**	**2 tons of petroleum products**
Tile Manufacturing Plants	**2**	**Suspended solids in the form of clays, fuel oils drippings**	**1 ton of clays, one tone of petroleum products**
Clay bricks manufacturing	**44**	**Clays and petroleum oils**	**4 tons of suspended clay particles/ day**
Car body shops and metal forming workshops	**25**	**Petroleum products, residues of Paints**	**2.5 tons of mixed petroleum and paint products with some pigments containing, lead, chromium, nickel as a source of color**
Seed millings and de-hulling	**2**	**Suspended organic starches**	**0.40 ton of suspended starches**
Plastic forming	**28**	**Oils and lubricants**	**3 tons of petroleum non-biodegradable**

			oils
Oil Pressing	2	Floating and Emulsified edible oils and lubricating petroleum oils	4 tons of BOD
Cotton Ginning	2	Non biodegradable oils and lubricants	0.1 ton of non-biodegradable oils
Animal feed formulation	4	Dissolved organics and suspended organic matter	0.4 ton of BOD and Suspended organics
Battery recharging	4	Highly concentrated sulfuric acid, lead plaques, plastic battery bodies	0.5 ton of highly contaminated acids with lead, 0.4 ton of battery lead plates, 0.3 plastic battery containers.

Table 4 **Small Scale Industrial Activities In El-Essenbellawane Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Discharged Liquid Wastes characteristics	Estimated loads/ year
Metal forming and lathing	**89**	**Emulsified cutting oils**	**9.0 tons of non-biodegradable oils**
Dairy plants	**4**	**biodegradable materials**	**4 tons of BOD and suspended solids**
Aluminum recycling and forming	**1**	**Suspended heavy metal particles**	**0. 5 ton of aluminum solid residues piled on the drains' banks**
Metals heat and manual forming, shaping and turning	**135**	**Metals scrap, cutting oils**	**1.35 ton of metal scrap leached to agriculture drains**
Battery recharging	**3**	**Acids**	**0.5 ton of acids, 0.3 tons of lead plates, 0.25 tons of battery plastic body**
Mechanical and manual wood works	**123**	**Wood residues on drain banks, washing paint liquors**	**1.0 ton of organic degradable matter, 0.5 non-biodegradable paints**
Metal plating	**4**	**Cyanides, acid solution with plating heavy metals**	**0.01 tons of heavy metals and 0.001 ton of cyanides**
Glass forming	**3**	**Petroleum oils**	**0.1 tons of oils**
Bakery	**10**	**Suspended**	**1.0 ton of**

shops		**and dissolved organics**	**BOD**
Plastic utensils manufacturing plants	**7**	**Petroleum oils as lost fuel, organic lubricants**	**0.5 tons of petroleum products**
Tile Manufacturing Plants	**8**	**Suspended solids in the form of clays, fuel oils drippings**	**2 ton of clays, one tone of petroleum products**
Clay bricks manufacturing	**44**	**Clays and petroleum oils**	**44 tons of suspended clay particles/ day**
Textile weaving plants	**2**	**Fuel and lubricating oils, dyes, dissolved inorganic salts**	**0.1 ton of mixed petroleum 0.001 ton of dyes with heavy metal contents as lead, chromium, nickel as a source of color**
Chicken nurseries	**3**	**Dissolved organics and suspended organic matter**	**3 ton of BOD and Suspended organics**

Table 5 **Small Scale Industrial Activities In Bani Ebeid Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Wastes Characteristics	Estimated loads Tons/ Year
Macaroni plant	**1**	**Bio-degradable materials**	**0.1 tons of BOD and suspended solids**
Metals heat and manual forming, shaping and turning	**34**	**Metals scrap, cutting oils**	**0.4 ton of metal scrap leached to agriculture drains**

Battery recharging	**2**	**Acids / Heavy Metals**	**0.25 ton**
Mechanical and manual wood works	**15**	**Wood residues on drain banks, washing paint liquors**	**0.01 ton of organic degradable matter, 0.5 non-biodegradable paints**
Metal plating	**1**	**Cyanides, acid solution with plating heavy metals**	**0.001 tons of heavy metals and 0.001 cyanides**
Bakery shops	**5**	**Suspended and dissolved organics**	**0.05 ton of BOD**
Plastic utensils manufacturing plants	**7**	**Petroleum oils as lost fuel, organic lubricants**	**0.5 tons of petroleum products**
Tile Manufacturing Plants	**2**	**Suspended solids in the form of clays, fuel oils drippings**	**0.2 ton of clays, one tone of petroleum products**
Clay bricks manufacturing	**44**	**Clays and petroleum oils**	**44 tons of suspended clay particles**
Ready made garment	**1**	**Fuel and lubricating oils,**	**0.001 ton of mixed petroleum**
Chicken nurseries	**2**	**Dissolved organics and suspended organic matter**	**0.5 ton of BOD and 2 tons Suspended organics**
Electronic assembly	**6**	**Metal scrap, lubricating oils**	**0.006 tons of lubricating oils**
Battery recharging	**5**	**Highly concentrated sulfuric acid, lead**	**0.5 ton of highly contaminated**

		plaques, plastic battery bodies	acids with lead, 0.4 ton of battery lead plates, 0.3 plastic battery containe rs.

Table 6 **Small Scale Industrial Activities In Temay El Amadid Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Waste Characteristics	Estimated loads Tons/ year
Metal forming and lathing	**26**	**Emulsified cutting oils**	**0.03 tons of non-biodegradable oils**
Aluminum recycling and forming	**30**	**Suspended heavy metal particles**	**1.0 ton of aluminum solid residues**
Metals heat and manual forming, shaping and turning	**216**	**Metals scrap, cutting oils**	**21 tons of metal scrap**
Battery recharging	**63**	**Acids**	**6 ton of highly concentrated acid with lead contamination, 3.0 tons of lead battery plates, 2.0 tons of batteries plastic boxes.**
Body shop and upholstery work for cars	**306**	**Metal residues on drain banks, washing paint liquors**	**1.0 ton of organic degradable matter, 0.5 non-biodegradable paints**
Metal plating	**11**	**Cyanides, acid solution with plating heavy metals**	**0.001 tons of heavy metals, 0.001 tons cyanide**
Bakery shops	**10**	**Suspended and dissolved organics**	**1.0 ton of BOD**

Table 7 **Small Scale Industrial Activities In Meniat El Nasr Urban and Surrounding Rural Areas (19) rural centers**

Industrial Activity	Number of Factories	Wastes Characteristics	Estimated Tons/ Year
Metal forming and lathing	**145**	**Emulsified cutting oils**	**1.5 tons of non-biodegradable oils**
Metals heat and manual forming, shaping and turning	**216**	**Metals scrap, cutting oils**	**21.6 tons of metal scrap**
Carpentry	**194**	**Solid wastes**	**0.2 BOD**
Body shop and upholstery work for cars and battery recharges	**155**	**Metal residues on drain banks, washing paint liquors**	**1.6 ton of degradable matter, 0.5 non-biodegradable paints**
Plastic molding plants	**9**	**Fuel oil and organic solvents**	**0. 1 ton of lubricating oils**
Bakery shops	**52**	**Suspended and dissolved organics**	**0.5 ton of BOD**
Dairy plants	**57**	**Dissolved biodegradable organics, dissolved inorganic salts**	**5 tons of BOD 0.1 ton of salts**
Gelatin products manufacturing	**30**	**Dissolved organics**	**0.3 ton of BOD**
Grains grinding and milling	**14**	**Suspended organic starches and fuel oils**	**0.14 ton of BOD**
Tile and Brick manufacturing	**34**	**Fuel oils and suspended clay matter**	**3.4 ton of suspended clay matter**
Ready made garments	**12**	**Fuel oils**	**0.01 tons of fuel oil and lubricant**

			s
Sugar cane squeezing	**51**	**Sugar solutions and baggas leaching on banks of drains**	**1.0 ton of BOD**
Chicken de-feathering and selling	**83**	**Feathers and offal are piled on banks of drains**	**0.8 ton of BOD**
Chicken breeding and eggs production	**37**	**Solid organic residues left on banks**	**3.7 ton of BOD**
Cotton ginning	**2**	**Edible oils**	**0.02 ton of fuel oil and lubricants**
Battery recharging	**17**	**Highly concentrated sulfuric acid, lead plaques, plastic battery bodies**	**1.7 ton of highly contaminated acids with lead, 1.0 ton of battery lead plates, 0.8 plastic battery containers.**

Table 8 **Small Scale Industrial Activities In Aga Urban and Surrounding Rural Areas (13) rural centers**

Industrial Activity	Number of Factories	Discharged Liquid Wastes characteristics	Estimated Load Tons/ Year
Metal forming and lathing	**145**	**Emulsified cutting oils**	**14.5 tons of non-biodegradable oils**
Metals heat and manual forming, shaping and turning	**216**	**Metals scrap, cutting oils**	**21.6 tons of metal scrap leached to agriculture drains**
Carpentry manual and mechanical	**136**	**Solid wastes**	**0.01 ton BOD**
Body shop and upholstery work for cars and battery recharges	**43**	**Metal residues on drain banks, washing paint liquors**	**0. 4 ton of organic degradable matter, 0.5 non-biodegradable paints**
Plastic molding plants	**29**	**Fuel oil and organic solvents**	**0. 3 ton of lubricating oils**
Bakery shops	**52**	**Suspended and dissolved organics**	**5.2 ton of BOD**
Textile and netting factories	**67**	**Fuel oils**	**0.67 ton of fuel oils**
Grains grinding and milling	**4**	**Suspended organic starches and fuel oils**	**0.04 ton of BOD**
Tile and Brick manufacturing	**17**	**Fuel oils and suspended clay matter**	**0.17 ton of suspended clay matter**
Battery recharging	**18**	**Highly concentrated sulfuric acid, lead plaques,**	**18.0 ton of highly contaminated acids**

		plastic battery bodies	**with lead, .9 ton of battery lead plates, 0.7 ton of plastic battery containers.**

Table 9 **Small Scale Industrial Activities In El Manzalla Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Wastes Characteristics	Estimated loads / year
Metal forming and lathing	**34**	**Emulsified cutting oils**	**3.4 tons of non-biodegradable oils**
Metals forming, shaping and turning and car body shops	**137**	**Metals scrap, cutting oils, lubricating oils**	**1 ton of metal scrap**
Glass manufacturing and cutting	**7**	**Minor oils and glass solid wastes**	**0.07 ton of oils**
Body shop and upholstery work for cars and battery recharges	**155**	**Metal residues on drain banks, washing paint liquors**	**0.15 ton of organic matter, 0.5 non-biodegradable matter**
Manual and mechanical carpentries	**192**	**Solid wastes, lubricating oils paint liquors**	**0.2 tons of oils and non-biodegradable paints and solvents**
Plastic molding plants	**1**	**Fuel oil and organic solvents**	**0.01 ton of lubricating oils**
Bakery shops and pastry shops	**29**	**Suspended and dissolved organics**	**2.9 ton of BOD**
Dairy plants	**4**	**Dissolved biodegradable organics, dissolved inorganic salts**	**4 tons of BOD 0.01 ton of salts**
Grains grinding and milling	**70**	**Suspended organic starches and fuel oils**	**0. 7 ton of BOD**
Tile and	**18**	**Fuel oils**	**0.18 ton**

Brick manufacturing		and suspended clay matter	of suspended clay matter
Metal plating	8	Cyanides, heavy metals	0.008 tons Cyanide and 0.00008 tons heavy metals
Aluminum Recycling	1	Fuel oil	Minor
Battery recharging	7	Highly concentrated sulfuric acid, lead plaques, plastic battery bodies	1.0 ton of highly contaminated acids with lead, 0.5 ton of battery lead plates, 0.5 plastic battery containers.

Table 10 **Small Scale Industrial Activities In El Azizia Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Wastes Characteristics	Estimated loads Tons / Year
Metal forming and lathing, turning and car body shops	**22**	**Emulsified cutting oils, metal scrap, and washing liquor**	**2.2 tons of non-biodegradable oils and paints**
Bakery shops and pastry shops	**29**	**Suspended and dissolved organics**	**0.29 ton of BOD**
Tile and Brick manufacturing	**1**	**Fuel oils and suspended clay matter**	**0.2 ton of suspended clay matter**
Battery recharging	**6**	**Highly concentrated sulfuric acid, lead plaques, plastic battery bodies**	**0.8 ton of highly contaminated acids with lead, 0.4 ton of battery lead plates, 0.3 plastic battery containers.**

Table 11 **Small Scale Industrial Activities In El Houta, New Alexandria, Frosat, El Bousrat, and El Nasiama and Meet Salsile Urban and Surrounding Rural Areas**

Industrial Activity	Number of Factories	Discharged Liquid Wastes characteristics	Estimated loads / year
Metal forming	**34**	**Fuel oils**	**3.4 tons of non-biodegradable oils**
Metal forming,	**25**	**Metals scrap,**	**2.5 ton of metal**

shaping and turning and car body shops		cutting oils, lubricating oils	scrap
Manual and mechanical carpentries	76	Solid wastes, lubricating oils paint liquors	7.6 tons of oils and non-biodegradable paints and solvents
Bakery shops and pastry shops	12	Suspended and dissolved organics	0.24 ton of BOD
Dairy plants	4	Dissolved biodegradable organics, dissolved inorganic salts	0.4 tons of BOD 0.1 ton of salts
Tile and Brick manufacturing	18	Fuel oils and suspended clay matter	1.8 ton of suspended clay matter
Chicken Nursery	14	Organic residues and dead birds	1.4 ton of BOD
Battery recharging	8	Highly concentrated sulfuric acid, lead plaques, plastic battery bodies	1.0 ton of highly contaminated acids with lead, 0.6 ton of battery lead plates, 0.4 plastic battery containers.

TABLE 12 Summary of Annual Pollutant Loads Discharged To the Main Drains Feeding El-Salaam Canal

1 **Pollution Constituants (tons/year)**	**Table 1**	**Table 2**	**Table 3**	**Table 4**	**Table 5**	**Table 6**	**Table 7**	**Table 8**	**Table 9**	**Table 10**	**Table 11**
2 Emulsified oil		4				0.03	1.5	14.5			
2.1.1 Solid aluminum		3	4	0.5		1					
BOD	72	44.3	4.4	8	0.65	1	0.2	5.25	7.6	0.29	2.04
Milk Fats And Whey		4									
Petroleum and paint products with some pigments containing, lead, chromium, nickel		5.3	5.5	0.1	2.001		11.44				
Clays		10	5	46	44.2		3.4	0.17	0.18	0.2	1.8
Biodegradable oils and floating solids		3									
Non-biodegradable oils		1	0. 1	9					3.4		
Suspended solids (non-biodegradable)		20									
Suspended starches		3.8	0. 4								
Highly toxic mater		0.02									
Petroleum non-biodegradable oils		0.2	3	1.6	0.006		0.13	0.97	0.08		11
Dissolved organics		2									
Leachates from solid waste		0.04		0.5							
Metal scrap			4	1.35	0.4	21	21.6	21.6	1		2.5
Bio-degradable matter				1	2.01	1	1.6	0.4	0.15		
Non-biodegradable paints				0.5		0.5	0.5	0.5	0.7	2.2	
Heavy metals				0.011	0.001	0.001			0.00008		
Cyanides				0.001	0.001	0.001			0.008		
Acids with heavy metals				0.5	0.25	0.6					
Salts (kg)							0.1		0.01		0.1

Table 13 Totals Of Pollutant Loads Discharged To The Drains

10 **Pollution Parameter**	**10.1 Total Annual Loading (Tons/Year)**
11 Bio-degradable material	
BOD	146
12 Emulsified oil	20
Suspended starches	4.2
Milk fats and whey	4.0
Biodegradable oils and floating solids	3
Dissolved organics	2.0
Salts	0.21
TOTAL	**179**
Bio-degradable material	
Clays	111
Metal scrap	69
Mixed petroleum and paint products	24
Misc. Suspended solids (non-biodegradable)	20
Petroleum non-biodegradable oils	17
Non-biodegradable oils	14
Solid aluminum	8.5
Non-biodegradable paints	4.9
Acids with heavy metals	1.4
Lactates from solid waste	0.04
Highly toxic matter	0.02
Heavy metals	0.01
Cyanides	0.01
TOTAL	**270**

3 DISCUSSION

Management of industrial waste discharges to drains is a critical issue not only in considering the potential direct human and environmental consequences associated with this practice, but especially in light of Egypt's present need to reuse drain water both directly through intermediate reuse, as well as indirectly through large scale mixing of fresh and drain water for agricultural irrigation.

Industrial pollution of drain water negatively impacts both forms of reuse. Pollutants of particular concern in regard to industrial wastes are:

- **Macronutrients, particularly inorganic forms of nitrogen and phosphorus;**
- **Toxic substances such as heavy metals as well as volatile and persistent organic compounds, and;**
- **Silt and suspended material (solid waste).**
- **Strong acids contaminated with heavy metals**

Risks (costs) associated with both direct and indirect reuse of drain water contaminated with excessive industrial wastes are to the health of farm workers, their livestock, and crop production. Further certain industrial contaminates may accumulate in food and fiber products exposing the consumer public to similar increasing health risks. Lastly the soil itself may be negatively impacted since continual application of drain water containing certain pollutants associated with industrial activity may lead to long-term reductions in land productivity.

Additional impacts resulting from mixing drain water polluted by industrial wastes with freshwater are similar to those experienced through direct reuse. Additionally, mixing drain contaminated by industrial pollution into the fresh water irrigation system can impart additional costs:

- **In the form of increased O&M requirements for the canal system, and;**
- **To water treatment facilities in the form of additional treatment requirements.**

Biodegradable industrial wastes contain various forms of nitrogen and phosphorus. Nitrogen and phosphorus are the primary catalysts of plant growth. Therefore, organic industrial wastes discharged to drains without treatment promotes the formation of aquatic plants and algae. If not properly managed excessive aquatic vegetation can clog waterways particularly when permitted to accumulate near hydraulic control structures thus increased vegetative growth equates to increased aquatic vegetation removal.

Mixing of drain water polluted by industrial wastes into the fresh water may degrade the water quality of the canal system. Many potable water treatment facilities draw raw water from the canal system. Mixing of fresh and drain water upstream of water treatment facilities may result in added potable water treatment requirements and their associated costs, or alternately, may decrease finished drinking water quality. Of particular concern with regard to this later point is the formation of trihalomethane, which may occur as a result of chlorinating water containing excessive dissolved refractory organic material.

Heavy metals, VOCs, and persistent organic residues are also a concern when considering industrial pollution. Heavy metals are of concern due to their persistence in the environment and their complex modes of transport. Heavy metal toxicology is highly complex and species specific. Generally, heavy metals are of concern as they have the ability to accumulate, concentrate, and even bio-magnify within the biotic web. Implying that while they may be in low concentration in polluted drain water, they may increase to toxic levels as they move up the food chain. Further compounding the concerns regarding heavy metals transport and persistence of metals in the environment. Generally, the majority of heavy metals received by drains is bound by insoluble clay particles and settled to the drain bed however this is most frequently not their final repository. Dredging activities associated with channel maintenance can re-suspend accumulated metals and the sediment to which they are bound. Under the proper pH conditions, insoluble heavy metals can be released in their dissolved organic forms. The organic forms of heavy metals are the most toxic.

Petroleum products resulting from industrial activities that utilize fuels and lubricating oils do not degrade and travel for long distances. A portion of these materials adheres to drain banks and to debris piled there. Often debris along drain embankments is burned as a form of informal disposal. Bi-products generated by burning plastics and residual petroleum wastes results in the formation of carcinogenic dioxins, benzo-pyrines and benzo-furains. Such persistent organic compounds are highly hazardous to health especially to newly born children, women and elderly people. Tables 12 and 13 illustrate the quantity of pollutants discharged collectively by micro-scale and small industries throughout the pilot project area. The total amount of non-biodegradable and toxic matter highly exceeds the biodegradable materials by approximately 91 tons.

Inert suspended silt (such as ceramic clay wastes) and other suspended material (solid waste) is of concern with regard to industrial pollution since suspended material can reduce light penetration thus suppressing biological activity and subsequently the assimilative capacity of the drain. Further silt tends to adsorb, and readily transport toxic pollutants such as VOCs and heavy metals.

The quantity of industrial wastes is expected to increase as a result continued development and expansion of Egypt's industrial sector. Corrective actions are necessary to improve management of this growing volume of industrial waste to insure that its unmanaged discharge to the country's drain system does not continue. Development of appropriate policy and implementation of effective management measures are critical to the future of Egypt's public health, environment and the continued development of agricultural and industrial sectors.

4 CONCLUSIONS

Conclusions drawn from Pilot Study #5 fell in to three categories:

- **Issues relating to large-scale industries,**
- **Those related to small and micro-scale industries, and lastly**
- **Those issues pertaining to industrial wastes in general.**

In the past, industrial pollution policy and associated enforcement actions have focused on large-scale industry. As a result of the continued efforts to enforce compliance to Law 48, large-scale industries are presently in the process of acquiring the capability to treat their liquid effluents to meet industrial discharge standards.

Perhaps the most significant findings of the Industrial Waste Management Pilot Study were those related to small and micro-scale industries. Until recently, medium (50 –150 workers), small (5-50 workers) and micro-scale (1-5 workers) industries have not been considered as a major contributor of industrial wastes to drains and canals. The survey of registered small and micro-scale industrial revealed that it is these enterprises that generate the bulk of untreated industrial waste-load to the drain system. Currently these industries are not required to permit their discharge. Many more not surveyed go unregistered entirely. If this is the case within the pilot area, could it not be considered typical of the Nile delta and indeed of all Egypt? Given that the number of small industrial enterprises will continue to grow with the population, it becomes imperative that Egypt develops a proper industrial waste management system. Drains should not be considered an acceptable dumping area for industrial waste regardless of how small the quantity. But how to begin to tackle this problem is not easy. Treatment of industrial wastes can be expensive, and small business generally does not bear access to large financial resources. Further small industries are

typically scattered in amongst residential areas adding to the complexity and cost of collection and treatment. Yet the significant impact of mismanaged wastes generated by small industry cannot be ignored.

Small and micro-scale industries must be officially recognized and included in industrial discharge management efforts in the future. With the increasing interest of the government to expand small and medium scale industries to create more job market for the idle it is important to consider seriously the management of such increasing volumes of discharges. Policy recommendations and management actions must be developed that appropriately address the unique management and disposal issues confronting medium, small and micro-scale industries.

While all industries must accept their share of the cost of industrial waste treatment the extent that this burden be levied on small industry must be creatively and carefully considered. Small enterprise should not be severely penalized or bear a cost which would severely hinder its sustenance to its employees since small industry make up a critical component to the national economy, employing a great number of Egyptians. One way to realize this objective is by empowering the Social Fund for Development to establish youth-sponsored projects, whereby money to support the program would be generated by collecting minimal fees from those workshops, generating all types of petroleum and hazardous chemicals and from selling it to the companies, where they could be reprocessed in different useful and salable products.

Lastly while it is of critical importance that future discharge of untreated industrial wastes not be permitted to enter the drain system. It must be realized that the positive effects of sound industrial waste management will not become reality over-night. These efforts will take time to realize. Therefore it is equally important to develop treatment strategies to address the industrial pollution already in the drain system and that, which will continue to enter in the near future.

Within the pilot area, there is a particular need to treat major drains before they get mixed with El-Salaam Canal for further agriculture use in Sinai. Appropriate treatment strategies for treating drain-water in El Salaam drainage should be explored. Technologies such as mechanical aeration, wetlands, and micro-bioremediation, to mention only a few, should be investigated as possible ways to enhance self-purification of drains feeding El Salaam Canal.

Current discharge compliance and waste management issues of these large and small industries were found to be quite different. What is apparent however is, that better management of both industrial categories is needed. To improve industrial waste management in drains, a two-pronged approach to management of industrial waste discharges to drains is recommended.

1. **The first is to eliminate or at least, severely restrict all future discharges of untreated industrial wastes to drains.**
2. **The second is to develop abatement strategies for industrial waste presently in the drain system.**

5 RECOMMENDED ACTION PLAN

As a first step toward realizing better management of industrial waste dumping to drains, an immediate plan of action was created based upon the conclusions of Pilot Project #5. The proposed plan addresses the current issues confronting industrial waste management and the discharge of these wastes to drain and

canals with in the study area. A summary of this immediate action is presented as Table 14.

The proposed action plan was developed based upon the findings and conclusions of Pilot Project #5. Successful implementation of the proposed plan will require the continued collaborative efforts of MWRI, EEAA, MOHP, NOPWASD, as well as Ministry of Mass Media, Ministry of Local Development, NGO's and, Industry leaders and representatives.

There are five major components to the plan:

1. ***Strengthen Monitoring And Law Enforcement Actions On Large-Scale Industries***
Despite current efforts however, response from large-industries has been more sluggish than expected largely due to lack of adequate incentives, enforcement, and follow-up monitoring. Better incentives for compliance are needed for large industries. Most importantly, adequate follow-up monitoring, and diligent enforcement to encourage continued compliance within a reasonable length of time must support these "better" incentives.

2. ***Surveys Of Industries And Industrial Wastes With Focus On Medium And Small Industries***
In order to develop effective industrial waste management strategies it is important to have an idea of the type, amount, and distribution of industries and their wastes. Surveys such as the one conducted under Pilot Project #5 are recommended for other regions of The Delta. Information gathered from such surveys should be entered into a comprehensive, interactive database to used to plan and track industrial waste management activities.

3. ***Public Environmental Awareness Campaign***
Awareness education and public awareness of the impacts of unmanaged industrial waste discharge to drains and other surface waters is an important step toward changing public behavior and realizing effective management policies. A comprehensive awareness campaign including local television and advertising, school education, and exposure of improper industrial disposal activities is recommended under the immediate action plan.

4. ***Compliance With The Environmental Pollution Controlling Laws***
Environmental Law 48 is not consistently applied and enforced. Measures to strengthen Law 48 and other environmental laws are necessary. Many industries, particularly medium, small and micro-scale are unregistered and cannot afford the costs of penalties and treatment. Incentives such as restricting penalties on newly registered industries, requiring new industries to conduct an environmental assessment before beginning operation, and industry consolidation and relocation programs should be investigated.

5. ***Promoting An Environmental Services Industry***
There is a dire need to collect hazardous wastes generated from the different micro-scale industries and reprocess them or sell them to other industrial plants to process it, or dispose of them properly. It is also very important for the local authorities to support small entrepreneurs in collecting solid and liquid hazardous wastes and non-hazardous wastes for reutilization and reprocessing. Collection of all types of wastes emanating from the micro-scale industries will prevent their impacts on water ways specially water drains while passing through the urban centers.

6 ACTION PLAN ACCEPTANCE

A workshop to present the findings of Pilot Project #5 and propose the recommended industrial waste management action plan was held in the Dakhalaiya Governorate Building in September 2001. During the workshop VIP attendants including His Excellency The Governor of Dakhalaiya, The Undersecretary, and local industry leaders enthusiastically accepted the proposed action plan. An outline of the workshop proceedings is included as Annex 1. A list of all attendees is included as Annex 2.

	Proposed Actions	Needed Participations
1	Strengthen monitoring and law enforcement action s on large scale industries	Ministry of Local Development at the Governmental level Ministry of Environment -EEAA Ministry of Health Irrigation & Drainage authority Industrial representatives
2	Survey of Wastewater from Medium and Small scale Industries Investigating wastewater generation, treatment and disposal from medium and small scale industries Assessing those industries for their wastewater and hazardous wastes Developing a safeguard and practically feasible plan on medium and small scale industries wastewater treatment and disposal	Ministry of Local Development at the Governmental level Ministry of Environment -EEAA Ministry of Health Irrigation & Drainage authority Industrial representatives
3	A Public Environmental Awareness Campaign Local TV programs and street posters School education and woman's leading role Awareness meeting at industry sites	Ministry of Mass Media Ministry of Local Development Ministry of Environment NGO's
4	Compliance with the Environmental Pollution Controlling Laws Creating measures to strengthen compliance of Law 48 and other environmental regulations Restricting penalties on unlicensed industries and preparation of new industries to the Environmental Impact Assessment Enhancing the industrial relocation program for small and medium industries within residential areas.	Local Development authority Industrial representatives EEAA Academic institutions and Ministry of Health Laboratory Ministry of Housing and Urban Planning Institutions
5	Promoting Environmental Service Industry Initiating private contractors to manage the wastewater collection, transportation and disposal services for medium and small scale industries Creating private enterprises to recycle and reuse selected components in the collected wastes and supporting them with the technologies to handle the liquid and hazardous wastes generated by small and Medium scale industries. Developing land fill for final wastewater treatment residue disposal	Industrial representatives EEAA authority Public Health authority Irrigation & Drainage authority Social Funds